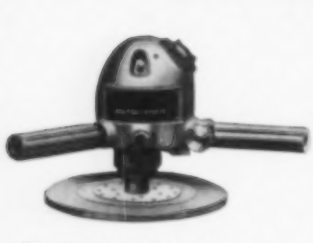
Compressed Air Magazine

Vol. 45, No. 9 London - New York - Paris September, 1940

MORE WORK *with* LESS EFFORT

The lighter weight of Ingersoll-Rand Modern Air Tools reduces operator fatigue. Their power and flexibility also help get jobs done quicker and better.

Use IR **AIR TOOLS**



Size 3F "Multi-Vane" Grinder with Sanding Head

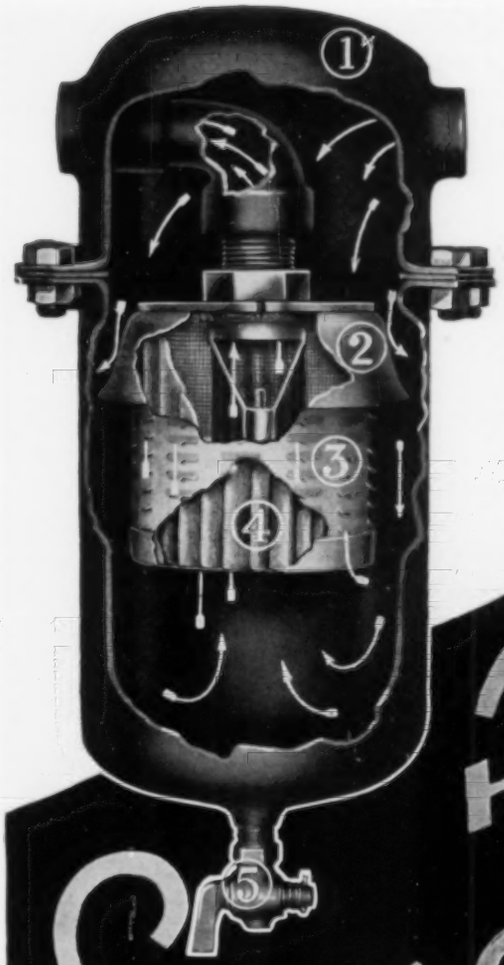
Size 00 "Multi-Vane" Grinder

Size 3GW "Multi-Vane" Grinder with Cup-Type Wire Brush

Ingersoll-Rand

11 Broadway, New York, N. Y.

948-8

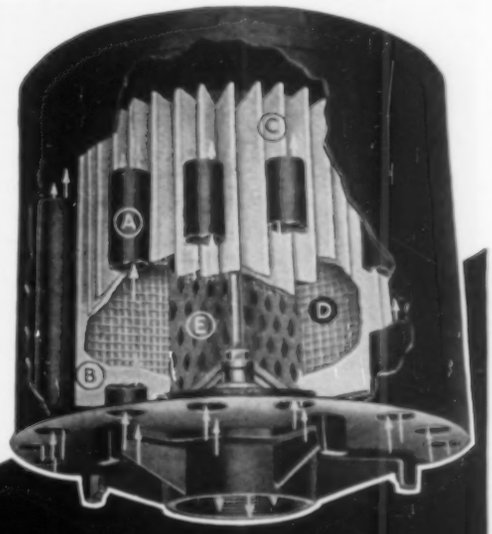


← MODEL CPH

for horizontal air transmission lines. Model CP for vertical lines. (1) container; (2) baffle; (3) housing; (4) insert; (5) drain cock.

MODEL DS →

Combination Silencer-filter for internal combustion engine and compressor intake. (A) Rectifying chamber (a series); (B) dry Feltex Filtering Medium; (C) Radial Fin Construction (D) rigid, galvanized mesh frame; (E) reinforcing tube.



HOW TO Save Money

WITH AIR FILTERS

» » » » Check over the machinery and processes under your supervision. Are gasoline, gas or Diesel engines, compressors, blowers or electric motors operating without efficient air filters? Do air-powered tools run on unfiltered air? Are air-using processes lacking clean, dry air? Is intricate, expensive machinery unprotected from dust?

AIR FILTERS ARE ECONOMIZERS

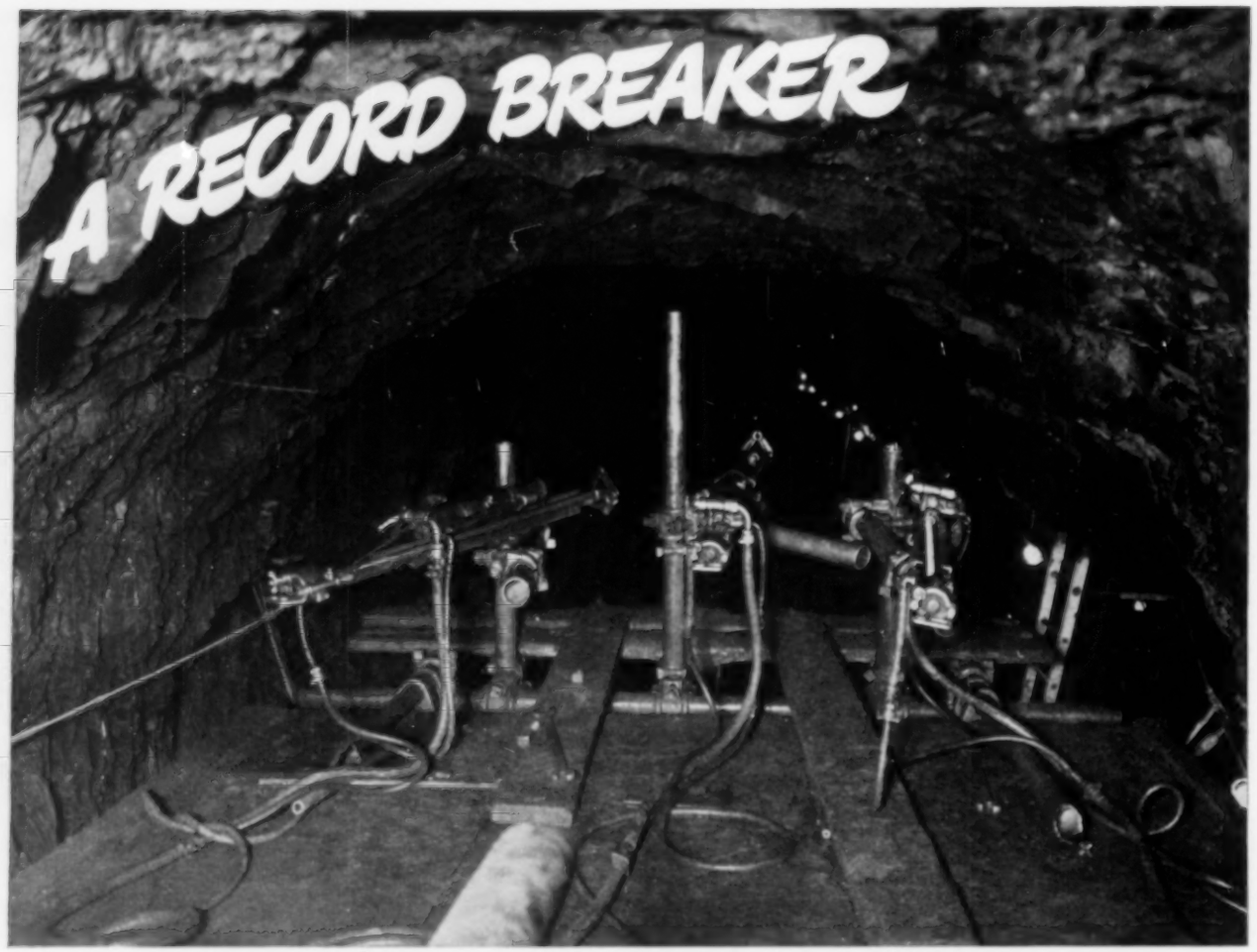
In every case, correct air filter installations will reduce operating expenses and maintenance costs. The reasons are simple. Abrasive dust is everywhere. Unless kept out by efficient filters, it scours away cylinder walls, wears out reciprocating parts, clogs delicate machinery. Foreign matter in air transmission lines (pipe scale, rust, dirt, oil and moisture) damages air-using tools; interferes with air-using processes. Facts and figures prove the savings made by high grade air filters. Use them everywhere and watch cost figures drop.

Protectomotor Air Filters 99.9% Efficient

Tests made by the University of California prove that Protectomotors possess an efficiency only .1% less than absolute. This extraordinary performance is the result of several factors: (1) the patented Radial Fin Construction provides large filtering area in small space, minimum restriction of air flow, (2) the famous Feltex Filtering Medium is tough, long wearing, efficient in stopping the finest dust particles, (3) Protectomotors are built under the closest possible supervision from high quality, selected materials. You can SAVE MONEY using them—write for catalog and data.

Air Filter PROTECTOMOTOR AIR FILTERS *Headquarters*

STAYNEW FILTER CORP., 7 LEIGHTON AVE., ROCHESTER, N. Y.



- - - 1619 - - - 1863 - - - 2060 FT. PER MONTH!

Bethlehem Superior Hollow Drill Steel

HERE'S the drill steel that helped in setting three world's records in the $231,000,000 Delaware Aqueduct —the huge water tunnel that connects New York with the upstate watershed through 85 miles of solid rock. Never before has there been a city water project of this size. And never before has an underground excavation proceeded so rapidly.

Working hundreds of feet below the surface of the earth, Walsh Construction Company drove the 18-foot-diameter tunnel 1619 . . . 1863 . . . 2060 feet per month (with each figure a new world's record)!

Bethlehem Superior Hollow Drill Steel has also been used to turn in outstanding excavation figures on New York's Queens-Midtown tunnel, on the mammoth Shasta dam, and in hundreds of other spectacular jobs.

Why?

Because Bethlehem Superior is built for the tough jobs. Only the cleanest, soundest steel is used. The hole is well centered, free from pits or hairline cracks. The drill rods are pretested for correct hardenability.

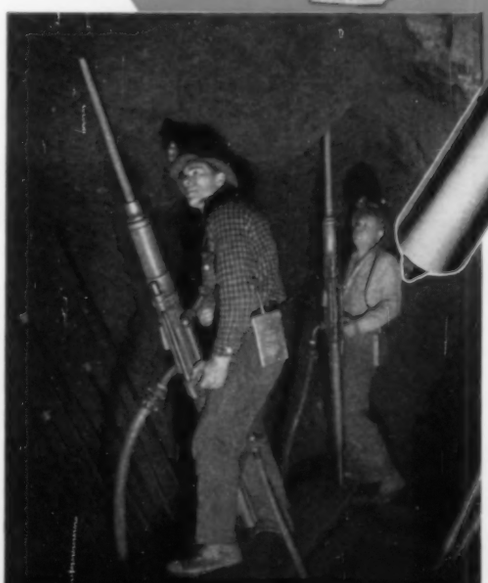
Try this record-breaking steel yourself. You'll soon see why it's a favorite with experienced drillers in all parts of the country.

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY

MAKES SKILLED MINERS EVEN MORE PRODUCTIVE!

the New Balanced R-58 Stopehamer



(Left) Reducing drilling costs in a western gold mine with R-58's and Jackbits.

● The R-58 is just what the drill runners ordered. Its weight is only 116 pounds. Its short overall length is balanced for easy handling. The hose and water connections, the throttle and the feed controls are ideally located for easy operation.

Underground, the advantages of its positive, flexible feed control, its durability and its fast drilling speed are obvious. These features are additional reasons why the R-58 increases production and substantially lowers drilling costs.

The easily handled drilling speed of the durable R-58 (it's the fastest Stopehamer Ingersoll-Rand has ever built) *makes skilled miners even more productive.*

More facts about the R-58 may be obtained by writing for Form 2647 or by contacting the Ingersoll-Rand branch nearest you. Don't overlook this opportunity to reduce your drilling costs. Get an R-58 today.

929-5

Ingersoll-Rand

11 BROADWAY, NEW YORK, N. Y.

Atlanta	Buffalo	Cincinnati	Denver	El Paso	Kansas City	Newark	Philadelphia	Pottsville	Scranton	St. Paul
Birmingham	Butte	Cleveland	Detroit	Hartford	Knoxville	New Orleans	Picher	Salt Lake City	Seattle	Tulsa
Boston	Chicago	Dallas	Duluth	Houston	Los Angeles	New York	Pittsburgh	San Francisco	St. Louis	Washington

Timken Bearing Equipped 155-MM gun.

Timken Bearing Equipped 155-MM howitzer.

Timken Bearing Equipped 75-MM field gun.

For Defense

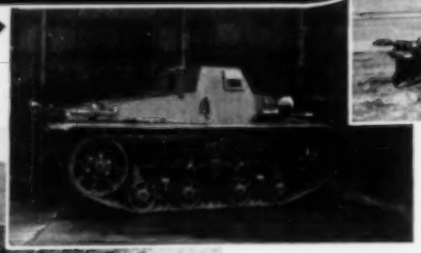
Wherever wheels and shafts turn, the extra strength, endurance and accuracy of TIMKEN Bearings are facilitating the mechanization of our military forces . . . both in the equipment itself and in the precision machinery necessary to produce it.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

Timken Bearing Equipped 37-MM gun.

Timken Bearing Equipped ➡ light tank.

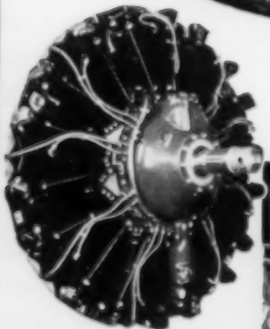
Timken Bearing Equipped 4-ton truck. ⬇



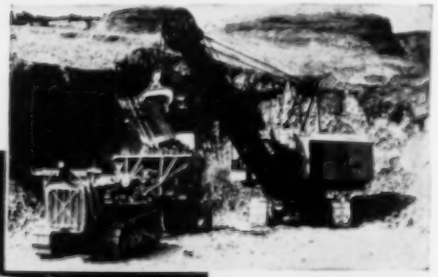
Timken Bearing Equipped 1½-ton truck. ⬇

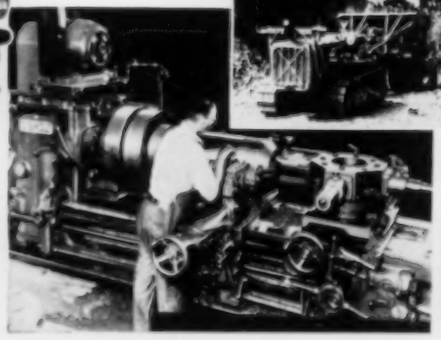
The U. S. Navy uses Timken Bearings in many kinds of equipment afloat and ashore.

U. S. military airplanes take off and land on Timken Bearing Equipped wheels.



Power for U. S. war birds—Timken Bearing Equipped engines.



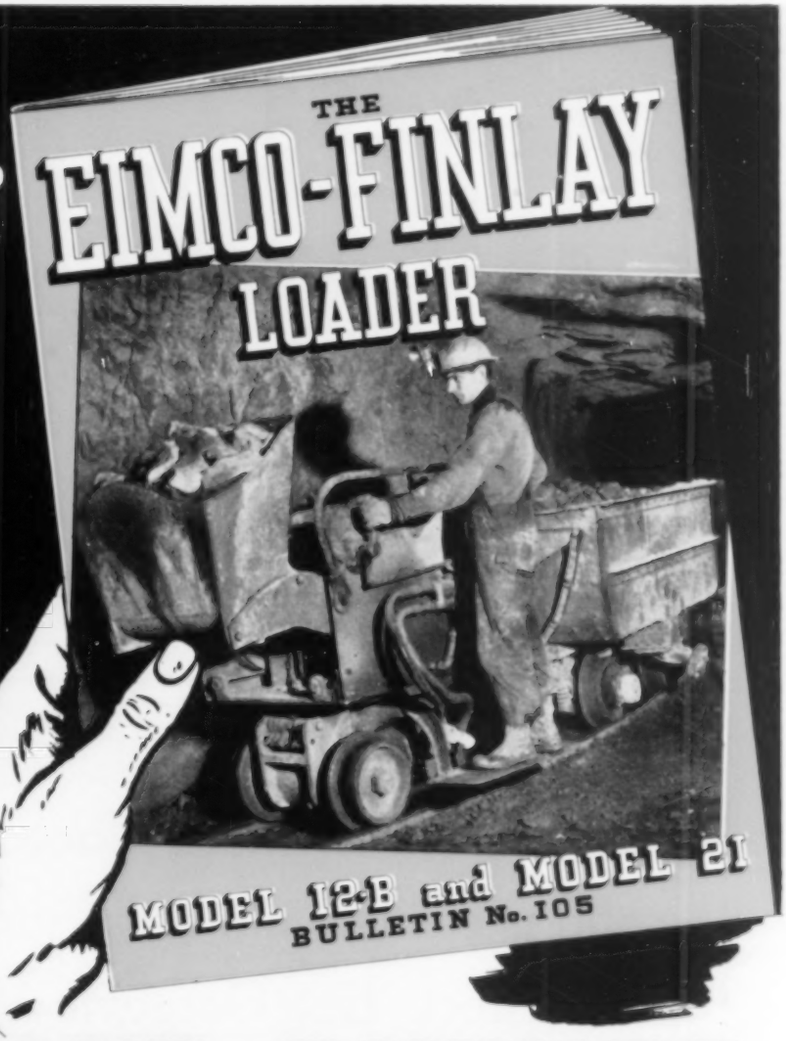


U. S. Army Engineers use a wide variety of Timken Bearing Equipped machines.

Millions of dollars worth of Timken Bearing Equipped precision machine tools will speed up our vast defense program.

-just off the press

36 Pages
8½" x 11"
Completely
Illustrated



This NEW "text book" on mechanical loading may easily help you to achieve

IMPORTANT SAVINGS

Bulletin 105 has been developed to provide Mining Engineers and Executives with COMPLETE INFORMATION regarding not only the constructional features, working dimensions, etc., of our latest-model Eimco-Finlay Loaders, but also regarding the most efficient and economical methods of using them in modern mines and tunnels.

Nearly half of its pages, therefore, are devoted to diagrammatic illustrations and factual data explaining various methods of operating procedure, track advance, car servicing, etc. This section also illustrates and explains how Eimco-Finlay Loaders are now used in many progressive mines for loading out of stopes and from raises—for backfilling in cut-and-fill stopes—for driving stub cross-cuts—for silling out in wide veins, etc. Much of this data represents very recent practice and has never before been available in type.

War-time conditions make this information particularly valuable to every mining man who is concerned with speeding up development work, increasing output, and keeping down production costs. Write TODAY for a free copy. The coupon below is for mutual convenience but a letter or post card will bring an equally prompt reply.

THE EIMCO CORPORATION
Salt Lake City, Utah, U. S. A.

NEW YORK
330 W. 42 St.

CHICAGO
333 No. Michigan Av

EL PASO
Mills Bldg.

SACRAMENTO
1217 7th Street

Sales Agents in all principal countries throughout the Mining World.

THE EIMCO CORPORATION, SALT LAKE CITY, UTAH, U. S. A.
I am interested in mechanical loading and would like to receive a copy of your new Bulletin No. 105, with the understanding that no charge or obligation of any kind will be incurred.

Name .....

Position or Title .....

Company .....

Address .....

It's the Humidity that Hurts—

UNLESS AIR DRILLS HAVE "CORRECT LUBRICATION"

IT TAKES A TOUGH OIL to "cover the waterfront" inside your air drills. Moisture in the air condenses and is carried into drills . . . causes a harmful washing effect. But Gargoyle Voco Engine Oil No. 1 maintains a husky film that simply won't wash off . . . helps minimize wear and costly delays.

CALL IN Socony-Vacuum for

You'll Profit from these "Exclusives"

☞ **SKILLED LUBRICATION COUNSEL** of a Socony-Vacuum man backed by 74 years' experience . . . the greatest in the Petroleum Industry.

☞ **A COMPLETE LINE** of Lubricants . . . the scientifically correct lubricant for every type of machine you now own . . . or will buy.

Correct Lubrication

NEW LUBRICANTS ahead of new needs . . . developed in close cooperation with machine builders by famous Socony-Vacuum laboratories.

HALF A MILLION CASE HISTORIES to guide our engineers in recommending the right use of these lubricants to earn Lubrication Profits for you.

DISTRIBUTION throughout the world of high-quality lubricants.

• • •

SOCONY-VACUUM OIL CO., INC.
Standard Oil of New York Division • White Star Division • Lubrite Division • Chicago Division • White Eagle Division • Wadhams Division • Magnolia Petroleum Company • General Petroleum Corporation of California

GARGOYLE
Lubricants

NORTON SERVICE in the Foundry

Two Types of Abrasive—aluminum oxide (Alundum) and silicon carbide (Crystolon)—in several varieties provide the right cutting action for any type of casting—steel, gray iron, malleable iron or non-ferrous.

Two Types of Bond—vitrified for wheels operating up to 6000 s.f.p.m. and organic (such as resinoid and rubber) for high speed operation—meet the requirements of all kinds of grinders.

Several Special Treatments—patented lubricating fillers—are available for certain types of jobs to prevent metal from sticking to the cutting points.

Consulting Engineering—to make this variety of abrasives, bonds and treatments of maximum benefit to you there is a Norton man in your district ready to help in selecting cost cutting wheels for your cleaning room. And back of him are the field specialists on foundry grinding and the engineering and research departments at Worcester. This is Norton Service for the foundry.

NORTON COMPANY, WORCESTER, MASS.

W-774

NORTON ABRASIVES

ON THE COVER

OUR cover picture shows a skilled artisan in the American Optical Company plant curling by hand the temples, or side bows, of a pair of eyeglasses. Dimensions and curves of temples are specified by blueprints, but the curlers become so expert that they rarely have to check their work for accuracy. The wire used for bows must be strong, extremely flexible, and resistant to acids and other corrosive agents. To obtain these properties, a wire sheathed with gold is employed. It starts out as a bar, 1 inch long and 1¼ inches in diameter, consisting of a solid core of base metal encased in a gold shell. By the application of great pressure the bar is gradually reduced in size and drawn into wire, the proportion of gold covering to alloy core remaining the same in the final wire as it was originally. The photograph was taken by Margaret Bourke-White.

•

IN THIS ISSUE

TUNNEL driving is big business. As evidence of this, there are eleven contractors on the Delaware Aqueduct doing work that calls for collective payments of more than $140,000,000. None of these jobs is more interesting than Contract 318, under which Pleasantville Constructors, Inc., is driving 36,600 feet of 17½-foot bore. This stretch is the low point in the system and includes the crossing of the Hudson River. Bad ground and water have had to be fought; but, as always, engineering skill has triumphed. Our leading article tells how the work is being done.

•

LEGEND has it that long ago a group of hungry Indians stalked a deer in western Cuba and built a fire to cook it. In scraping around to get rocks for a rude fireplace, they discovered copper ore. This colorful story of the beginning of the Matahambre Mine, Cuba's leading copper producer, belongs to folklore, the authentic account of the mine's origin being presented in this number by T. G. Murdock. The older tale, however, had its influence on the selection of the name *Matahambre*, which means, literally, "kill hunger."

•

THE illustrations for *Wooden Wonderland* are a bit spooky and the yarn itself tests one's credulity. Nevertheless, contemplation of the bizarre, inanimate zoo of Mountainair, N. Mex., affords diversion from the realism of a world that has too many dark clouds hanging over it.

•

STEAM and diesel-engine partnerships have been found to be profitable in many industries. A newcomer to the ranks is the distilling industry. One of the largest whiskey producers has added diesel power to his advantage, as told by H. C. Blankmeyer.

Compressed Air Magazine

Copyright 1940 by Compressed Air Magazine Company

Volume 45 **SEPTEMBER, 1940** Number 9

C. H. VIVIAN, *Editor* — J. W. YOUNG, *Advertising Manager*
A. M. HOFFMANN, *Assistant Editor* — J. F. KENNEY, *Business Manager*
D. Y. MARSHALL, *European Correspondent*, 243 Upper Thames St., London, E.C.4.
F. A. McLEAN, *Canadian Correspondent*, New Birks Bldg., Montreal, Quebec.

EDITORIAL CONTENTS

Driving a Tunnel Beneath the Hudson River—*R. G. Skerrett* 6226
Mining Copper in Cuba—*T. G. Murdock* 6233
Handling and Storing Liquefied Gases in Bulk 6237
Wooden Wonderland—*Jim Kirby* 6238
Modern Distillery Uses Diesel Power—*H. C. Blankmeyer* 6240
Editorials—Better Mine Ventilation—Construction for Defense 6242
Sleuthing for Compressed-Gas Flasks 6243
New Multiple-Stripe Road Marker 6243
Machine Heats and Quenches Inner Walls of Metal Cylinders 6244
Molasses-Topped Roads 6244
Hidden Pipe Lines Do Not Slow Up This Power Shovel 6244
Power Shovel Controlled by Air Clutches 6245
New Ventilating Duct 6245
Portable Compressors for Odd Jobs 6245
Plating Cylinder Bores 6245
This and That 6246
Feats and Facts 6247
Industrial Notes 6248

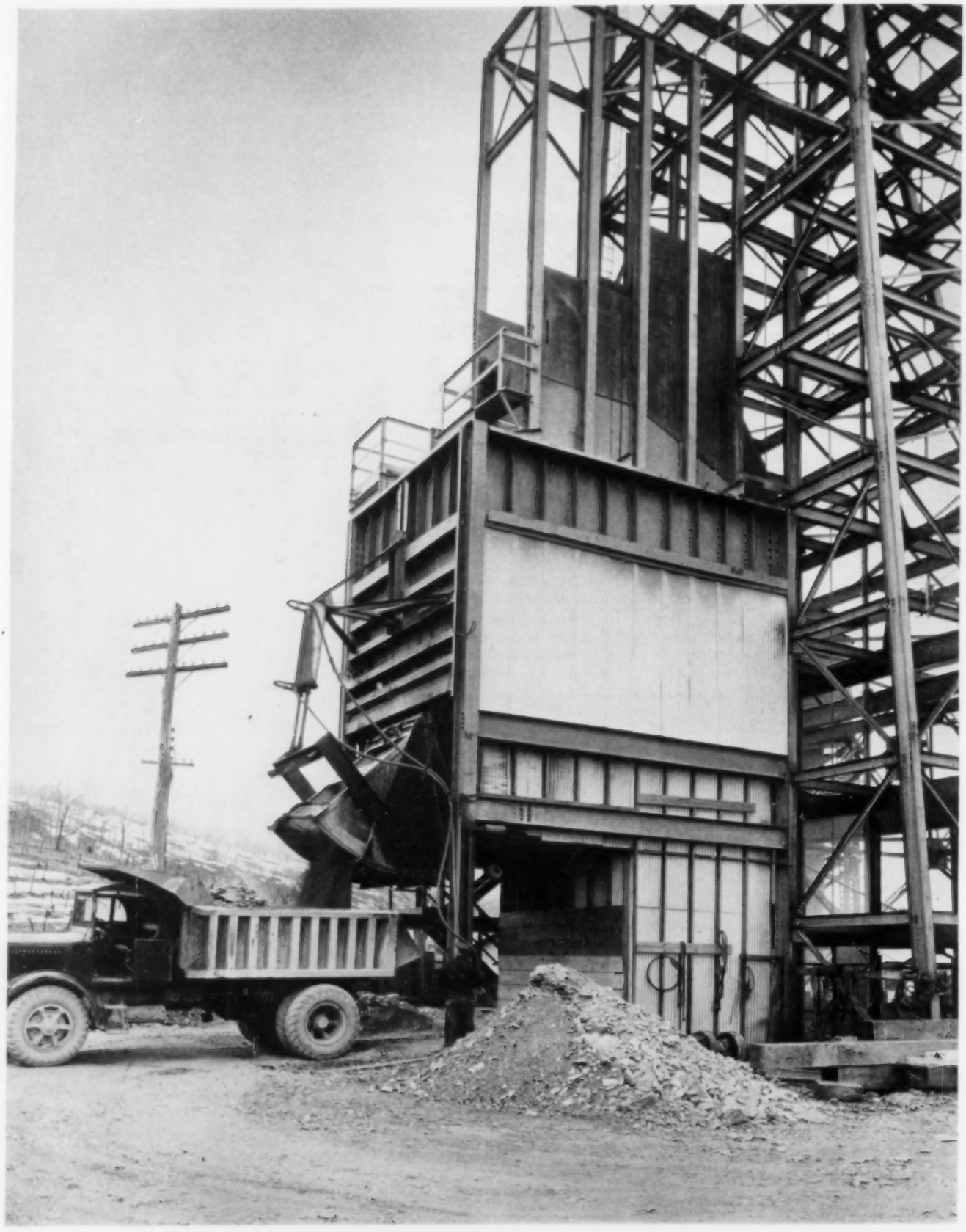
ADVERTISING INDEX

Air-Maze Corporation 15
Atlas Drop Forge Co. 16
Bethlehem Steel Co. 4
Bucyrus-Erie Company 20
Burgess Battery Company 25
Conrader Company, R. 24
Cook Mfg Co., In . C. Lee 11
Eimco Corporation, The 7
General Electric 18
Goodrich Company, The B.F. 13
Hercules Powder Co., In ., The 21
Industrial Clutch Company 17
Ingersoll-Rand Co. 5, 12, 22
Jarecki Manufacturing Co. 16
Lebanon Steel Foundry 19
Maxim Silencer Co., The 16
National Forge & Ordnance Co. 26
Naylor Pipe Company 25
New Jersey Meter Company 24
Norton Company 10
Socony-Vacuum Oil Co., Inc. 8-9
Square D Company 26
Staynew Filter Corporation 3
Texas Company, The ..... 4th Cover
Timken Roller Bearing Co., The 6
Toledo Pipe Threading Mach. Co., The 26
Vogt Machine Co., Inc., Henry 23
Wagner Electric Corporation 26
Westinghouse Electric & Mfg. Co. 14
Willson Products, Inc. 24

A monthly publication devoted to the many fields of endeavor in which compressed air serves useful purposes. Founded in 1896.

CCA Member Controlled Circulation Audit.

Published by Compressed Air Magazine Company. G. W. MORRISON, president; J. F. KENNEY, vice-president; F. E. KUTZ, secretary-treasurer.
Business, editorial, and publication offices, Phillipsburg, N. J.
Advertising Office, 11 Broadway, New York, N. Y.
Annual subscription price: domestic, $3.00; foreign, $3.50. Single copies, 35 cents.
Compressed Air Magazine is on file in many libraries and is indexed in Industrial Arts Index.



MUCK HOPPER AT SHAFT 5A

The skip dumps its 12-cubic-yard load into the muck hopper, which has a capacity of 125 cubic yards. From the hopper, muck is loaded into an 8-cubic-yard truck, as shown here. The hopper gate is operated by the two compressed-air cylinders that are visible above it. The muck is hauled to a nearby disposal area, one truck usually sufficing for this service.

Driving a Tunnel Beneath the Hudson River

R. G. Skerrett

VENTILATING BLOWERS

At each shaft are two Ingersoll-Rand Motorblowers for ventilating the tunnels. Each unit is driven by a 100-hp. motor and handles 9,600 cfm. of air. By means of 4-way valves the blowers can be operated either to deliver fresh air to a heading or to withdraw the smoke and gases resulting from blasting. The ventilating ducts are 28-inch Spiralweld pipe.

THAT one river may underrun another river, Pleasantville Constructors, Inc., is driving a tunnel nearly 7 miles long the lowermost section of which passes beneath the broad sweep of the Hudson. The stream that is to follow the man-made subterranean course will have its sources on the southerly slopes of the Catskill Mountains and enter the tunnel from a reservoir about 28 miles inland to the west of the Hudson. It will eventually supply the City of New York with 700,000,000 gallons of water daily.

Contract 318, under which Pleasantville Constructors, Inc., is working on the great Delaware Aqueduct, calls for the driving and lining of 36,600 linear feet of tunnel that will have a finished diameter of 13½ feet. The contract covers a section of the 44.6-mile Rondout-West Branch Tunnel that is to link the Rondout Reservoir in the mountains west of the river with the West Branch Reservoir in the upper watershed of the Croton Hills eastward of the Hudson. The section in question passes underneath the Hudson 600 feet below the surface of the water and has a minimum covering of 300 feet of bedrock, not to mention the overlying river bed. Where the underpass has been driven, the Hudson is 3,400 feet wide, and the tunnel will be subjected to a hydrostatic head of 1,440 feet, which is nearly 200 feet greater than the height of the Empire State Building. The bursting stress of the pent-up water will be about 640 pounds per square inch; and the conduit must, therefore, be built well and soundly.

The tunnel section covered by Contract 318 starts about 3½ miles west of the Town of Marlboro, Ulster County, N.Y., and traces a southeasterly course to a point about a mile northwest of Fishkill Village, Dutchess County, on the east side of the Hudson. It is being driven from two concrete-lined shafts, Shaft 5A, which is 10,980 feet west of the river, and Shaft 6, which is 820 feet east of the river—the interval between the two being 15,200 feet. Shaft 5A, which connects directly with the tunnel line, is 1,020 feet deep and 14 feet in diameter. Shaft 6, from the bottom of which a 170-foot access drift runs to the tunnel line, is 685 feet deep. Since it will later serve as a

drainage shaft for the entire Rondout-West Branch Tunnel, its diameter is 26½ feet. Both shafts, the access drift at Shaft 6, and the two stub tunnels, each about 200 feet long, at each shaft bottom were constructed by the Frazier-Davis Construction Company under an earlier contract.

Before Pleasantville Constructors, Inc., started work in May, 1939, the two shafts stood idle six and eleven months, respectively, and during that time accumulating water filled Shaft 5A to a height of 723 feet above the tunnel invert and Shaft 6 to a height of 298 feet. The volume of water that had to be removed before tunneling could be started was 4,280,000 gallons. The unwatering at each shaft was done with a cylindrical steel bucket, 4 feet in diameter and 8 feet 4 inches long, having a capacity of 800 gallons. A simple, circular, 12-inch flapper valve in the bottom lifted to admit water as the bucket was submerged and closed when pressure was applied on it as the filled bucket started upward. The latter was hung from a nonspinning, ⅞-inch cable and was raised and lowered by a 150-hp. mine hoist. A bull chain served to open the valve when the bucket reached the surface and was swung into position to discharge.

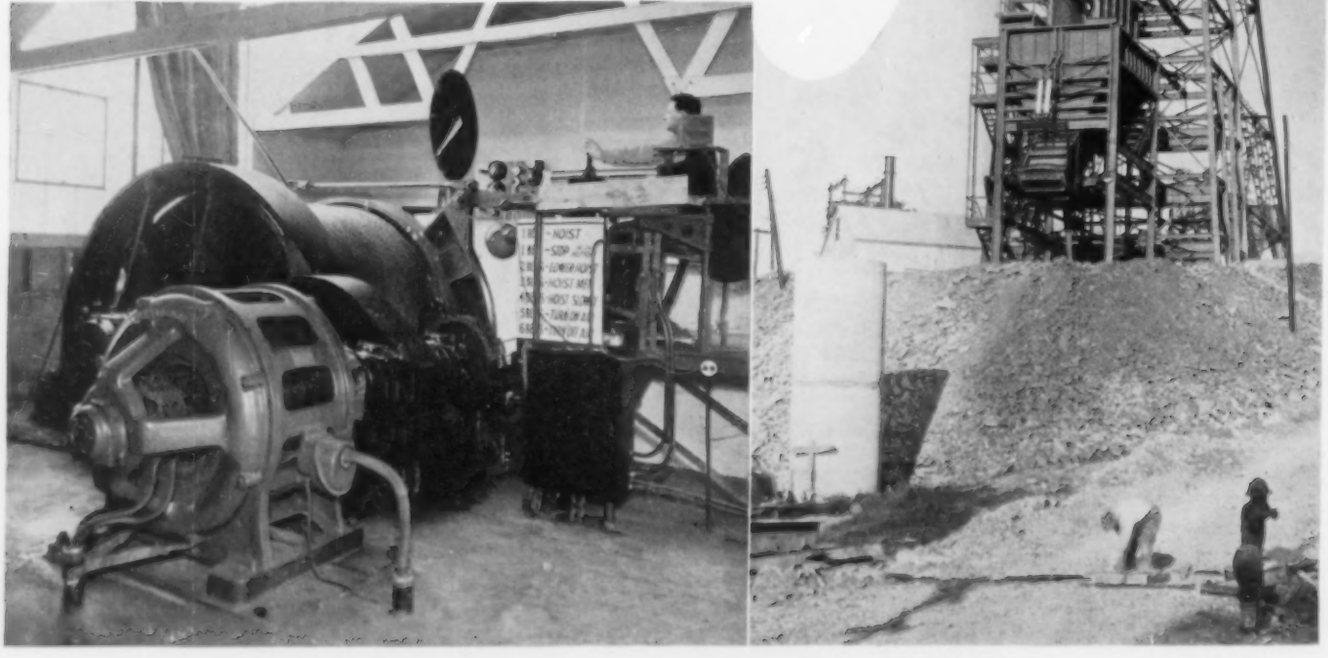
At Shaft 5A the bailing rate averaged 130 gpm., and at Shaft 6, with a shorter lift, it averaged 180 gpm. At the former, unwatering to the springing line was accomplished in the course of twenty-two 8-hour shifts; and the water was lowered to a corresponding level at Shaft 6 in twenty-seven 8-hour shifts. All told, 3,750,000 gallons of water was thus removed, and the 530,000 gallons then remaining in the stub tunnels was pumped out. Tunneling was started at Shaft 5A on August 24, 1939, and at Shaft 6 on September 9, 1939.

Before asking for bids on the Rondout-West Branch Tunnel section of the Delaware Aqueduct, the Board of Water Supply of New York City made extensive exploratory borings along the line of the river crossing and elsewhere to ascertain the character of the rock and the different formations that would have to be pierced in driving the tunnel throughout the entire scope of Contract 318. These, together with the disclosures made in sinking shafts 5A and 6, indicated that 5¾ miles of the tunnel would penetrate the Hudson series of shales, slates, and sandstones, and that the remaining 1¼ miles, approximately, would have to be driven through Wappinger limestone. A fault in the latter formation was discovered in making the advance borings about 1,200 feet inshore from the west side of the river, but its extent was not determined. That fact, however, loomed as a possible cause of trouble for the tunnel driver.

With all available information assembled and duly weighed, Pleasantville Constructors, Inc., decided to tool its plant thoroughly to meet the particular task in hand, and to do this with new equipment that would assure the most effective interrelation of all operations—some being built especially for the purpose. Further, the company assembled a highly qualified and carefully coördinated field organization that would be continually on the job and able to plan quickly what best to do under changing conditions of work or to meet an emergency. The care taken in choosing the personnel and the matériel has been fully justified by the results.

Because Shaft 6 is field headquarters, and because its north heading has been driven under the river and has met with the greatest difficulties at times, a description of the operations carried on from there should be of especial interest. It should be understood that much of the equipment at Shaft 6 is duplicated in make and kind at Shaft 5A, and that the tunneling procedure at all the headings has generally been the same.

Shaft 6 is topped with a 140-foot headframe of fabricated steel members erected by bolting. The frame carries a 12-cubic-yard skip and a counterbalancing man-and-material cage with a load capacity of 20,000 pounds. The skip and cage are sus-



HEADFRAME AND HOIST

There is a headframe over each of the two shafts on this contract. The one shown is 140 feet high. It is equipped with a single-drum mine hoist (below) driven by a 350-hp. motor, and exerts a pull of 53,000 pounds on each of the 1¾-inch wire ropes that handle a 12-cubic-yard muck skip and a man-and-materials cage of 20,000 pounds capacity.

RECONDITIONING DRILL BITS AND RODS

Drilling is done with Jackbits, and they are resharpened by hot milling. The Ingersoll-Rand JMA hot mill in use is shown in No. 1. After being milled, bits are reheated and quenched for hardening, No. 2. Jackrods are threaded by a Toledo drill-rod threading machine, No. 3, and their shank ends are swaged by an I-R No. 54 sharpener, No. 4. On many jobs, threads are now being forged in a sharpening machine.

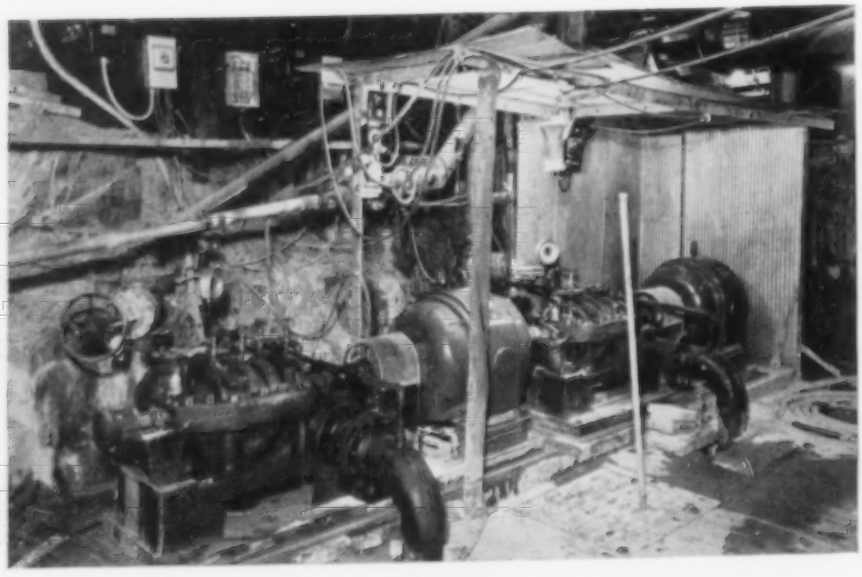
pended from 1¾-inch cables traveling over two 9-foot-diameter sheaves at the top of the headframe and are operated in balance from a single 9-foot-diameter, 6-foot-face drum—the cables taking off from both the top and the bottom of the drum. The pull on each cable is 53,000 pounds. The hoist is a Vulcan unit driven by a 350-hp., 2,300-volt Westinghouse motor. The traveling speed at Shaft 6 is 400 feet a minute; but at the deeper Shaft 5A it is 600 feet.

For the purpose of ventilating Shaft 6 and the two tunnel headings driven from it, there are installed above ground two Ingersoll-Rand Type FS-575 turboblowers each driven by a 100-hp., 2,300-volt motor. Each unit delivers 9,600 cfm. of air to the 28-inch Naylor spiralweld vent pipes that carry the air down the shaft and north and south to the headings. Air for operating pneumatic equipment is supplied by a surface compressor plant composed of two Ingersoll-Rand PRE-2 machines. One of these has a capacity of 1,500 cfm. and is driven by a 300-hp. motor and the other a capacity of 1,900 cfm. and is driven by a 400-hp. motor. Each is fitted with 5-step automatic-sequence, load-factor control.

Also above ground are a machine shop and a blacksmith shop to condition the drill steel and the detachable bits used at all the tunnel headings. The blacksmith shop contains the following equipment of Ingersoll-Rand make: a No. 54 Leyner sharpener, a 45SP shank-and-bit punch, a No. 500 cut-off wheel, a No. 8 pedestal grinder, a JMA hot-milling machine, a JKT Jackbit quenching tank, and an RV-¾ pump for circulating water in the quenching tank. In addition it has a Tate-Jones & Company oil-fired furnace and a Toledo drill-rod threading machine.

Near Shaft 6 and at the surface there is a well-equipped first-aid room and shaft office, and for the convenience of the workers is provided a 64x20-foot change house with ten showers, six toilets, four washbasins, 250 steel lockers, and three drinking fountains. Medicated soap is furnished at all showers and basins; and footbaths at the shower entrances contain a solution of Westochlor to minimize the likelihood of athlete's foot.

At the start of work three pumps—two 300-gpm. and one 1,000-gpm.—were placed in the pump chamber at the bottom of Shaft 5A, while two 300-gpm. and two 1,000-gpm. pumps were installed in the corresponding chamber at Shaft 6 to



PUMP STATION

A section of the pump room at the bottom of Shaft 6. It contains six centrifugal pumps having a combined capacity for lifting 7,800 gpm. of water to the surface.

handle the estimated maximum volume of water likely to enter the tunnel during the driving operations. Water-bearing rock was encountered in the north heading of the latter shaft when it was about 1,000 feet from the river. That was the first indication of trouble ahead and the possible need of a larger pumping plant at Shaft 6. Consequently, two more pumps, each with a capacity of 2,600 gpm. against a head of 850 feet, were placed at the bottom of that shaft and provided with a 16-inch discharge line, and two 2,000-gpm. Ingersoll-Rand 8AFV Type pumps, driven respectively by 75- and 60-hp. motors and capable of operating against heads of 120 and 90 feet, were installed at the river heading. At the same heading, and likewise for gathering service, there was another pump with a capacity of 1,000 gpm. at a 105-foot head. These units discharged through a newly laid additional line 18 inches in diameter. The advisability of this increased pumping capacity will be evident presently.

Tunnel driving at each heading is being done by means of a jumbo or drill carriage that is moved to and from the face by a storage-battery locomotive and has a working crew of thirteen men. Each jumbo is 30 feet long, from 10 to 12 feet high, rectangular in cross section, and made up of structural-steel members. It travels on 36-inch-gauge track of 56-pound rails laid on timber ties. At the front end, the carriage is fitted with columns and bars on which are mounted ordinarily six Ingersoll-Rand DA-35 drifters with motor feed and 36-inch sliding cone shell. These machines drill from 40 to 50 holes each round—the number being determined by the character of the rock encountered. At the rear, provision is made for mounting a single drifter for drilling pinholes. Drill rods are 3, 5, 7, and 10 feet in length, and starting bits are 2⅛ inches in diameter, each succeeding one being $\frac{1}{16}$ inch smaller. Holes are bottomed at 1¾ inches.

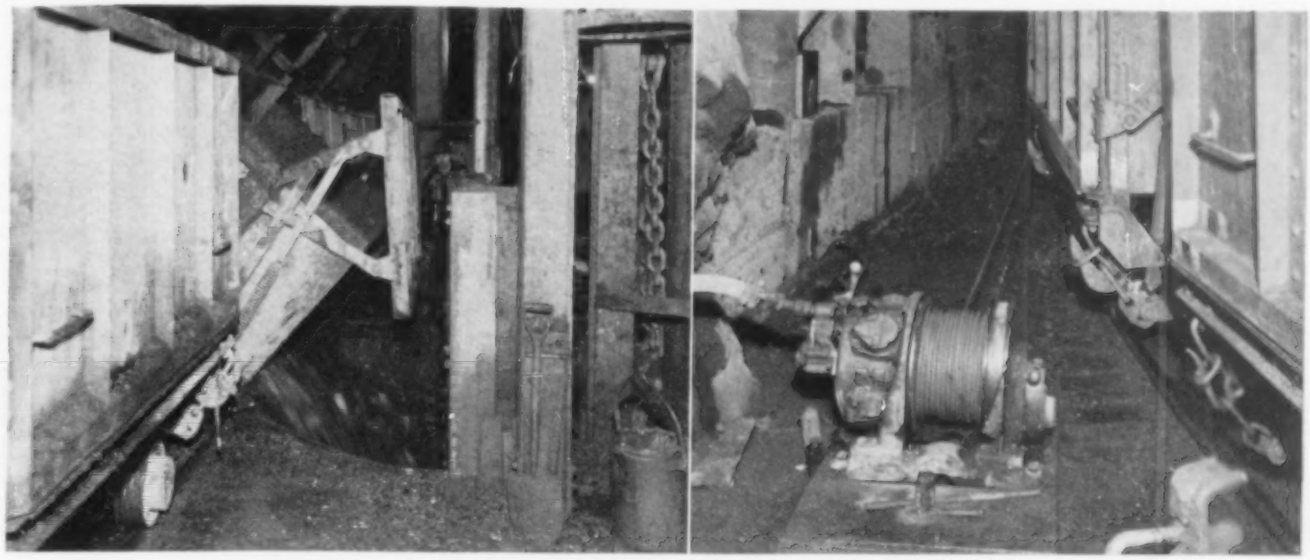
When the drilling of a round is completed, the jumbo is pulled back from the heading and shunted on to a siding at a safe distance. The holes are then blown out with compressed air preparatory to loading them. The explosive comes from a magazine outside the shaft and is delivered to the heading in a sturdily built, covered wooden car. Before the latter approaches the heading, power from the electric lines is shut off, and the face is illuminated with photo flood-lights that draw current from the battery of a locomotive.

According to data furnished by the contractor, the loading of the holes is as follows: "The exploders vary from No. 0 delays in the cut holes to No. 8 delays in the lifters, or bottom holes. The average charge of powder used is 350 lbs., or about 700 sticks and 50 exploders. The wires are then hooked up to lead lines from a safety box several hundred feet back in the tunnel." By way of precaution, the main switch, blasting switch, and blasting line are placed opposite the water mains—drainage and supply—and the air and the power lines so as to be well away from stray currents. Just before firing, a screen of water atomized with compressed air is shot diagonally across the tunnel about 60 feet back from the heading. This is done by what is known as the Underwood spray, which originated on another Delaware Aqueduct contract and was fully described in the August issue. The spray, which is kept running until the muckers start their work, serves to confine the dust and most of the gases resulting from a shot and makes it possible for those men to go to a heading about fifteen minutes sooner than they otherwise could with safety. Immediately after the blast, and continuing for fifteen minutes, the ventilating blower is reversed to suck the gases and dust away from the heading. After that the blower resumes its normal function of delivering fresh air.

Mucking is done at each heading with a Goodman-Conway No. 60 mucker driven by a 60-hp., 440-volt motor. During a mucking cycle one of these machines will load an average of 30 cars in about two hours. As each leading car of a train of six

DRILL CARRIAGE

The front of a drill jumbo, equipped with six motor-feed DA-35 drifters. At the rear end there is mounted a single drill of the same type for putting pinholes, etc., in the roof and sides.



CAR PULLER AND DUMP

Muck trains made up of six cars each are shunted to a siding at the shaft bottom. Each car, in turn, is then pulled by an Ingersoll-Rand HU air hoist (right) into position for dumping into a chute from which the hoisting skip is loaded. Locomotives are therefore available at all times for haulage. The car is tipped for dumping by a pneumatic ram.

is loaded, the train is pulled back so that another empty can be placed on the track from a siding and drawn up to the loading position by a cable operated by an electric, single-drum, Size 107 "Tugger" hoist mounted at the rear of the mucking machine—the last-loaded car having pulled the cable to the siding. The empties are shifted from the latter to the main track by a portable switch that permits the cars to be moved at right angles to the main track.

The hauling at each shaft is done by four General Electric, 13-ton, storage-battery locomotives. Each has a maximum drawbar pull of 6,500 pounds at 6.5 miles per hour, is driven by two 45-hp., 110-volt motors, and has a battery made up of 60 Exide Ironclad cells of 781 ampere-hours. The latter are carried in a battery box that can be lifted bodily from a locomotive or replaced by a 4-arm grab traveling on an overhead trolley that runs the length of a battery storage station and extends into the tunnel. There is a charging station near the bottom of each shaft large enough to hold five batteries; and the charging time ranges from six to eight hours, depending upon the degree of discharge.

American Car & Foundry Company 5-cubic-yard side-dump cars equipped with roller bearings and automatic couplers are used for hauling muck. On arriving at the dumping station at the foot of a shaft, each car is tilted by an air ram and discharges into a chute that delivers the spoil to the skip in a pit below the tunnel line. The loaded cars are run on a nearby siding, and each is pulled up to the dumping point by a Utility hoist.

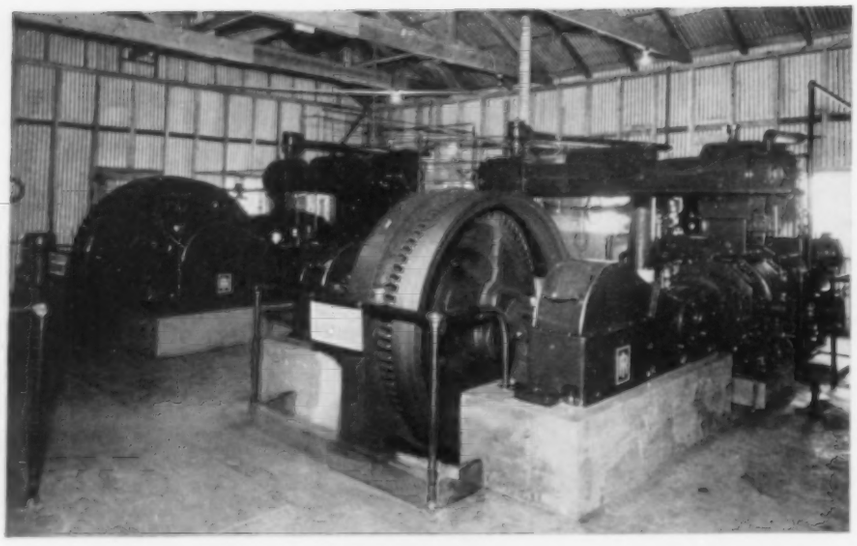
The 4-inch water-supply line for feeding the rock drills and for wetting down the muck pile, and the 6-inch compressed-air line for the drills and for other services, are extended as each heading advances, and so, too, are the vent pipes which are 28 inches in diameter and come in sections each 30 feet long. After the latter have been lowered to the bottom of a shaft in groups of four, each length is transported to the point of installation by a flat car having two movable half-round yokes in which to set the pipe. There it is raised to the coupling position by a hand winch which operates a cable which, in turn, causes the yokes surmounting two telescopic columns to move upward until the section is at the desired height for attachment. This equipment has proved handy, adaptable, and a time saver. Another apparatus that has been of much use is what is known as a 1-man jumbo—a small carriage mounting a single drill that has served to drill miscellaneous holes for hanging piping, for grouting, etc.

On May 7 of this year, the north heading from Shaft 6 and the south heading from Shaft 5A were 2,800 feet apart, and on August 15, despite the difficulties experienced with the former, the two headings met and were holed through. This represented a combined advance of 32.6 feet a day, or 16.3 feet at each face. The excavated tunnel section has an average diameter of 17.5 feet; and work was carried on in three shifts a day and six days a week.

To appreciate this performance one should recall what was done at the high period of operations on the pressure tunnel for the existing Catskill Aqueduct under the Hudson River. The crowning achievement in driving that epoch-making tunnel during 1911-1912 was a 300-foot advance in a month, which was considered an astonishing record. At Shaft 6 of the Delaware Aqueduct, the average progress per heading during a 6-day week has been 240 feet, or 40 feet a day, which is four times the footage made in a day on the older tunnel under the river. Under especially favorable rock conditions, Pleasantville Constructors, Inc., has driven as much as 314 feet at a single heading in the course of six working days, or 52.8 feet in three shifts.

The time between shots on Contract 318 ranges from four to five hours, contingent upon rock conditions, delaying causes, etc., and the average progress per round has been approximately 9 feet. Several advances are normally made at a heading each 24 hours, as contrasted with but one a day when the pressure tunnel of the Catskill Aqueduct was driven. The much faster work now done is largely due to greatly improved mechanical aids, to more effective explosives, and to the means by which all the loaded holes in a face can be fired at one time.

While the north heading from Shaft 6 was penetrating Hudson shale, progress was maintained at a good clip. The rock broke so uniformly that traces of the rim holes with their paralleling grooves are seen repeatedly on the walls. No appreciable volume of water entered the tunnel then. The rock had a tendency to spall when exposed to the air, but that was checked by thinly guniting the wall surfaces. Continuing from the shale into Wappinger limestone, still no water was struck until the north heading was 500 feet in the latter formation and at a point under the river 1,000 feet short of the west shore line. There exploratory drill holes, driven in the lower left-hand quadrant of the heading, tapped a flow of 75 gpm. This was allowed to enter the tunnel without recourse to grouting because the pumping plant at Shaft 6 then had a maximum capacity of 2,600 gpm. However, in the course of the next few rounds, the in-



COMPRESSORS

Two synchronous-motor-driven Class PRE-2 compressors, having a combined piston displacement of 3,400 cfm., are provided at each shaft to furnish air for drilling and for other purposes.

flow increased to 350 gpm. The water manifestly followed a fault of ascertained strike and dip, most of it entering from the tunnel roof. Again the contractor elected to go on with his driving before attempting to halt the water by grouting.

This first water-bearing zone was passed after the heading had been advanced 180 feet; but, on reaching a point 110 feet beyond, another flow of 350 gpm. was encountered, this time in the lower right-hand quadrant of the heading. The total inflow was thus raised to 700 gpm. The river was undoubtedly the source of the water, for when the latter was checked, and a gauge was applied, a back pressure of 260 pounds per square inch was registered. At that stage driving at the north heading was stopped and grouting operations taken in hand at two points—one at the heading and one at the water-bearing zone rearward.

At the heading, ten holes 19 feet deep were drilled in the face, pipes inserted, and grout injected; but the grout failed to do its work because of the shattered state of the rock. Seven vertical holes having an average depth of 11 feet were then drilled in the invert about 15 feet back from the heading. Grout forced into these holes to refusal and at a pressure of 1,100 pounds per square inch during thirteen 8-hour shifts was effective in stopping all but a trifling inflow. At the water-bearing area well back from the heading the leakage was reduced to about 3 gpm. by grouting the rock through holes drilled in the invert and in the side walls approximately parallel to the water-bearing seam. This operation covered a period of substantially seventeen 8-hour shifts. Tunnel driving was resumed when grouting at the heading was completed.

Grouting was done with a pump developed by George D. Thomas, master mechanic on the contract. The unit has a capacity of 40 gpm. when operating at a pressure of 400 pounds per square inch and has been described by one of the engineering force of the Board of Water Supply as follows: "This pump is an outside center-packed plunger pump of the simplex, double-acting type operated by compressed air. It has no curved parts or pockets to be clogged with grout, and the valve outlets are outside connected with the pipe for ease in cleaning. As a result of these features, including a special type of steel ball valve, it is possible to grout continuously for a number of days without any delay beyond washing out the pump and holes and the pipe connections once or twice in an 8-hour shift."

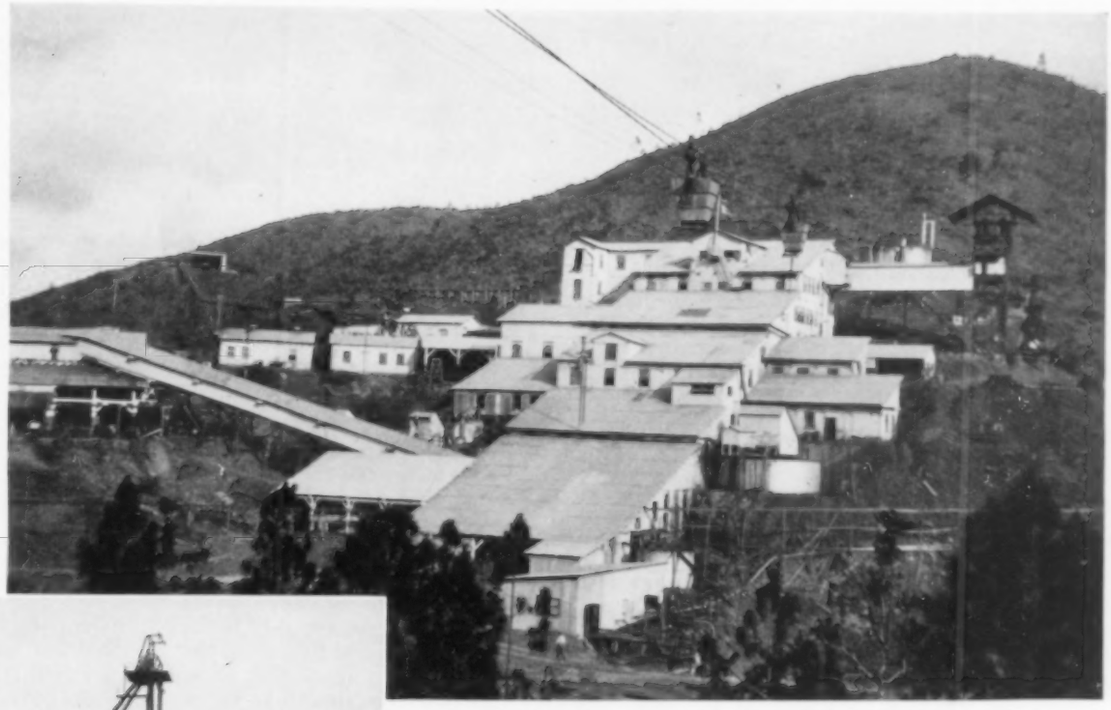
After the inflow of water was arrested as described, the procedure at the heading was modified by drilling test holes at each round: two 16-foot holes in the invert at an angle of 40° with the vertical and four 19-foot holes in the upper part of the tunnel arch and at the springing line. These holes were grouted whenever water was met, which was twice before the tunnel had progressed to a point beneath the west shore of the river. This was about the middle of February of the current year.

From the foregoing date up to March 22 rapid advance was made; but then the tunnel drivers were confronted with conditions at the north heading that seriously slowed up progress for a considerable time thereafter. The situation that developed in the last half of March is thus explained by Pleasantville Constructors, Inc.: "Before excavating through this section, additional pumping capacity was installed both near the face and at the bottom of the shaft to handle adequately the water to be encountered. In addition, a concrete bulkhead 20 feet long was constructed about 80 feet from the face, having a pressure side face of 25-foot diameter, a shaft side face of 18-foot diameter, a passageway 6 feet 3 inches wide and 11 feet 4 inches high, a Dutch-type steel door of 7 tons, and a frame of 2 tons. Embedded in the bulkhead are the vent pipe and other pipes for pursuit of the work ahead. This provision made it possible to seal off the tunnel north of the bulkhead should a situation arise that would be due to a long interruption of the power supply or the occurrence of a sudden inrush of water from the porous limestone confronting the workers."

After those provisions were made, the north heading was pushed ahead through the troublesome water-bearing ground by excavating five separate small drifts until sound rock was again encountered. This work was necessarily slow and at times discouraging. The contractor resorted to steel roof support, steel interlining, reinforcing steel, and a considerably heavier concrete lining than that prescribed to provide a satisfactory envelope for the 13½-foot tunnel where it passes through this fault zone. While these operations were underway, nothing was done to block off the inflow lest recourse to grouting should build up dangerous pressure upon the rock walls of the tunnel. The increased pump capacity was relied upon to dispose of the incoming water. Grouting, reinforcing, and the placing of the extra-massive concrete lining was done step by step and very deliberately.

The cheerfulness, competence, and alertness of the men at that spectacular heading while carrying on their difficult job was quite typical of the general spirit and resourcefulness displayed elsewhere on the contract. After weeks, the wet ground was left behind, and the north heading from Shaft 6 was again pushed onward at good speed. All the while, the south heading from Shaft 5A was advancing steadily toward the point of holing through. Also, during the same period, the north heading from Shaft 5A and the south heading from Shaft 6 have been carried forward steadily and rapidly and without encountering any troublesome rock and hampering water.

Contract 318 was awarded Pleasantville Constructors, Inc., March 2, 1939, on its bid of $10,679,710. The corporation is composed of the following well-known and experienced contracting organizations: W. E. Callahan Construction Company, Dallas, Tex.; Foley Brothers, Pleasantville, N.Y.; Spencer White & Prentis, Inc., New York, N.Y.; and Winston Brothers, Minneapolis, Minn. The officers are Lazarus White, president; Carl L. Swenson, vice-president; G.H. Wilsey, treasurer; A.L. Kadela, secretary; and I. Isenberg, assistant secretary and assistant treasurer. The directors are: Lazarus White, W.E. Callahan, Carl L. Swenson, Edmund A. Prentis, Paul Grafe, J.C. Agnew, Edward T. Foley, and Luther S. Oakes. Handling the operations in the field are J.R. Glaeser, general manager; R.V. Johnson, general superintendent; R. King, chief engineer; C. Gail, equipment superintendent; Fred Cherry, superintendent Shaft 5A; and George Foster, superintendent Shaft 6.



Mining Copper in Cuba

T. G. Murdock

MINE, MILL, AND SHIPPING PORT

In the center is shown the No. 1 Shaft at Matahambre. It has three compartments and is bottomed at 2,000 feet. The concentration mill is seen at the top. It was originally designed as a combination gravity and flotation mill, but since 1928 only selective flotation has been practiced. Concentrates from this mill are transported 6 miles by aerial tramway to the Port of Santa Lucia, which is pictured in the bottom view. There they are lightered out to ore boats anchored in the harbor and loaded for shipment to a smelter at Carteret, N. J.

THE average person thinks of Cuba, and rightly so, as a most delightful spot with an ideal climate and beautiful scenic attractions—in short, a splendid place to spend a vacation, long or short. To others the island stands out because of its relation to American history, and to still others it is truly the "world's sugar bowl" (in the crop year 1937-38 it contributed 9 per cent of the world's production of that prime necessity) and grower of a tobacco that is a universal favorite. Few people are aware of the fact that there are copper mines on the island. In comparison with other countries, and even certain American states, the Cuban output of this mineral would rank rather low as regards tonnage and value. Nevertheless, the island does have such an industry, in fact it enjoys the unique distinction of being the scene of the first efforts made by white men in the Western Hemisphere to mine ore solely for its copper content. This occurred at Santiago del Prado (El Cobre) in 1532.

The Island of Cuba, the "Pearl of the Antilles," lies in a subtropical zone; has a population of 4,011,088; covers an area of 41,164 square miles; and is divided into six provinces. It is approximately 750 miles long, following its curved axis, and varies in width from 20 to 90 miles. The most mountainous regions are in the extreme western Province of Pinar del Rio and in Oriente, the easternmost province where the elevations reached are higher than those in the eastern part of the United States.

CUBA'S COPPER DEPOSITS

The most important ore bodies are in the extreme eastern and western provinces. The first mining by white men in the Western Hemisphere exclusively for copper was done at El Cobre near Santiago in 1532. The principal operations today are at Matahambre, near the western end of the island.

While many copper outcrops have been found and worked, the majority of them have proved to be rather small deposits of irregular size and shape occurring generally along the contact between limestone and intrusive. There have been two deposits, however, the important producers of El Cobre and Matahambre, that did not turn out to be of this kind. The first named is situated on the north side of the Sierra Maestra Mountains and 8 miles west of Santiago on the south coast of Oriente Province. Matahambre is in a low range of hills that is composed of alternate beds of shale and quartzite. It is on the north flank of the Sierra Organos Mountains in the western part of Pinar del Rio Province and about 6 miles southeast of the Port of Santa Lucia and approximately 100 miles from Havana, both on the north coast.

El Cobre Mine enjoyed a picturesque career between 1832, when it was discovered, and 1918, when it was closed down; and its story is one of perseverance and difficulties such as are the lot of pioneer efforts everywhere. Its managements were numerous, and working methods varied from the earlier crude ones to what in their day were the latest. From 1832 to 1868 inclusive, about 770,000 tons of ore were produced, and from 1904 to 1917 inclusive, 698,148 tons were milled and 177,000 tons of concentrates, averaging approximately 10 per cent copper, were shipped. The peak output was in 1911, when 94,900 tons were mined.

The other producer, Minas de Matahambre, is of more recent development and, like many mines in other countries, its discovery was accidental. In 1912, Carlos Miranda crept under a rock to seek shelter from a sudden shower, and while there his attention was attracted to some pieces of oxidized ore. These he took to Dr. Alfredo Porta, a pharmacist of Pinar del Rio who became interested and filed claims. Doctor Porta and Manuel L. Diaz, Secretary of Public Works, formed an association—Porta y Diaz—and started exploratory work at once. In less than a year high-grade ore was mined from the oxidized zone of the veins, which were found under a shallow soil cap. In 1921, the American Metal Company, Ltd., acquired a majority interest in the new company that had been organized—Minas de Matahambre, S. A., which has since that date been operated under the management of Dudley D. Homer.

The ore bodies occur in the form of pipes of primary chalcopyrite that have been found in four mineralized zones. Horizontal development in general consists of footwall drifts from which crosscuts are driven to the hanging wall at regular intervals. Chute raises are driven from the crosscuts, and silling is done above the 10-foot pillars left standing. While silling is still in progress, raises are driven to the next level. The flat-back, cut-and-fill method of stoping which permits hand sorting of waste in the stopes, is practiced and has proved itself to be best suited to the nature of the ground. The wider ore bodies generally require square-set timbering by the time they are stoped midway between levels. Some mining is done without timbers, and some shrinkage has been carried out. All mining and exploratory work are under a bonus system, with Cuban *capataces* or "jigger bosses" in direct charge, each being responsible for a certain section of the mine. The Matahambre system of sand filling stopes is used. It was developed at Matahambre in 1926, and by means of it deslimed mill tailings, in the form of +200-mesh sand which constitutes an ideal filling material, are transferred back into the mine through rubber-lined piping. This hydraulic system accomplishes the twofold purpose of disposing of waste and supporting mined-out areas.

The workings are reached by three shafts—Nos. 1, 2, and 3 which are now bottomed, respectively, on the 2000-, 2800-, and 1700-foot levels. No. 1 is a man-and-materials shaft having two hoisting compartments and a manway and pipe compartment. It is served by a Wellman-Seaver-Morgan double-drum hoist powered by a 350-hp. motor. No. 2 is primarily the ore-hoisting shaft. It has four compartments lined with steel shaft sets, and is equipped with a Nordberg double-drum hoist provided with Ward-Leonard Ilgner control and driven by an 800-hp., direct-current motor. This hoist serves the two ore-handling compartments, while a Lidgerwood "chippy" hoist raises and lowers a duralumin cage in the materials compart-

TYPICAL MINE WORKERS AT MATAHAMBRE

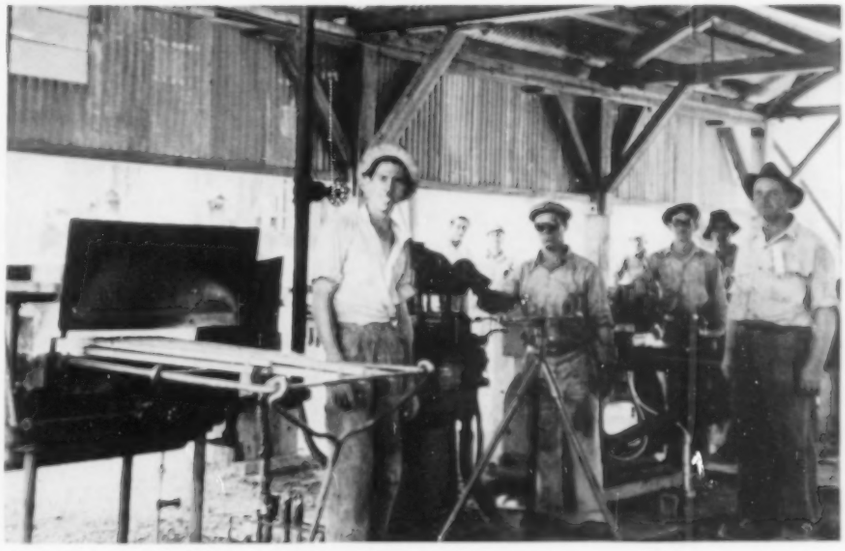
Labor turnover is small, in fact many of the workers have given from ten to twenty years of continuous service. The men are justly proud of being identified with an industry that was started more than 400 years ago and have experienced no difficulty in adapting themselves to modern methods and equipment. Note the electric cap lamps, which were adopted four years ago. The group shown here worked three years without a lost-time accident.

ment. The fourth is a pipe, cable, and manway compartment. The miners go up and down in two triple-deck cages which are removed as soon as ore-hoisting starts and replaced by 5-ton skips and single-deck skip tenders' cages. Shaft No. 3 has three compartments—two for hoisting and a pipe and manway compartment. It also is used for carrying men, materials, and waste, and is equipped with an Ottumwa double-drum hoist with a 200-hp. motor.

The compressor plant is located in No. 1 Hoist House and contains an Ingersoll-Rand PRE-2 machine and two Imperial Type 10 units, with respective piston displacements of 3,600 and 2,400 cfm. There is also a small ER-1 compressor rated at 250 cfm. This supplies air for the brake cylinders of No. 1 Hoist on Sundays and holidays, obviating the necessity of operating one of the larger units.

The drilling equipment includes three types of machines, all of Ingersoll-Rand manufacture. N-75 and DA-30 drifters do the drifting and crosscutting; S-49 and JA-55 Jackhamers are used for stoping and shaft sinking; and raises are driven with automatically rotating stopers. All drilling is done wet, water being piped to each face. Machinery for reconditioning steel includes two IR-50 steel sharpeners, two oil-fired furnaces, a hot miller, and a No. 500 cutoff wheel. Diamond drilling is an important operation underground, and four units are in continual service there.

From the individual stopes on each level the ore is hauled to the nearest ore pass in end-dump cars of 1-ton capacity by Mancha storage-battery locomotives. Ore from passes above the 1400- and 2100-foot levels is retrammed and dumped into ore pockets at No. 2 Shaft for loading into skips through measuring cartridges operated with compressed air. There is an additional pocket on the 2400-foot level for the ore mined between it and the 2100-foot level, and another one is under construction on the 2800-foot level. Rehaulage on the 2100-foot level is done by Granby side-dump cars of 4-ton capacity and a 6½-ton General Electric storage-battery locomotive. Tracks are of two gauges: those down to the 2100-foot level are of 18-inch and those on the latter and below it of 24-inch gauge. Battery charging is carried out in a surface station in No. 1 Patio and in an underground station on the 2100-foot level at No. 2 Shaft.



STEEL-SHARPENING CREW AT ITS POST

About 800 pieces of steel are handled daily in this shop. To these men, a steel is a *pistolo*, a furnace is a *horno*, and the sharpening operation is *afilar*. However, the result is the same in any language—a sharp piece of steel for the man at the drilling face.

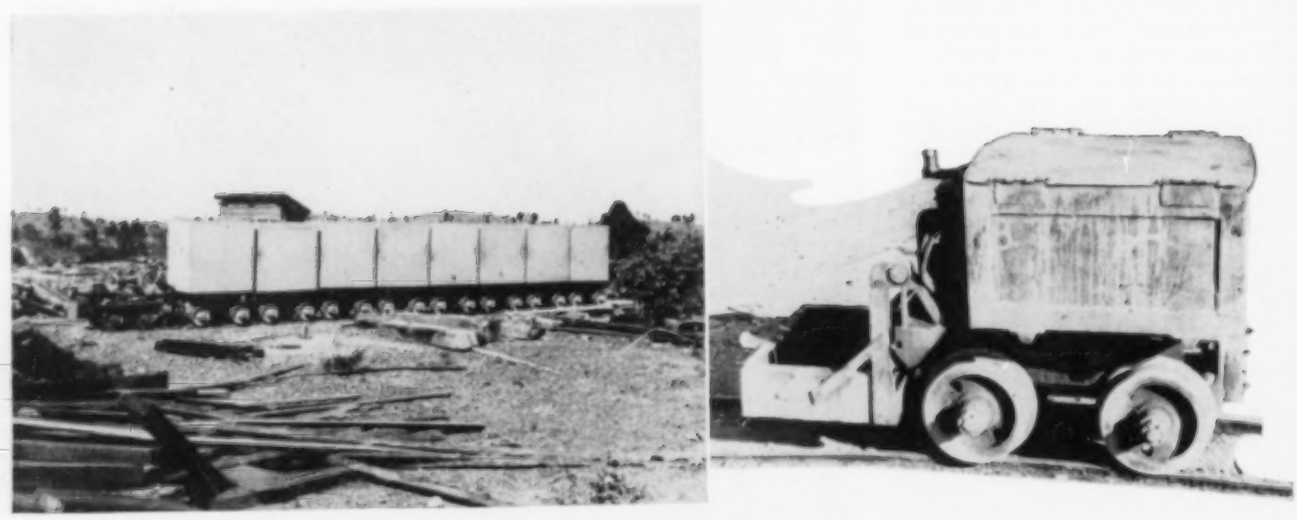
HOMES OF WORKERS

Comfortable houses, with electricity and running water, are provided free of charge to all employees. Modern sanitary facilities have been installed, and a special sanitation department administers the service, with emphasis on mosquito elimination. A bacteriological laboratory carries on researches in the field of tropical diseases, and these activities have received national recognition. There are a modern hospital and schools in the camp, which has a total of 4,500 inhabitants.

The mine would hardly be considered a wet one, for approximately one-quarter of the water pumped is used for the hydraulic filling of stopes with sand from the mill tailings. All water originating above the 2100-foot level feeds into a large sump on that level. This sump is provided with facilities for settling the solids and for cleaning alternate sections of it with little effort. The solids are pumped by a No. 7 Cameron air-driven pump into special closed tank cars of 300-gallons capacity, and these "slime cars" are trammed to No. 2 Shaft, hoisted to the surface, and dumped there by merely opening a release valve in the bottom of each car. This arrangement has proved to be far superior to hauling sump residue in standard ore cars, which invariably leak and dirty track, shaft, and shaft yard. Worse than that, however, was the discovery that the hoisting cables became impregnated with the slimes dripping from the shaft members, and that the slimes, containing iron pyrite, caused the cables to corrode internally.

There is a modern pumping station on the 2100-foot level and this takes the water from the sump and delivers it to the suction of a pumping station on the 1400-foot level. The latter relays it to the surface and also handles local accumulations of water in a small sump. Both stations are equipped with three Ingersoll-Rand 4-NT Cameron centrifugal pumps each of which is rated at 400 gpm. Any water that collects on the lower levels is raised to the 2100-foot level by four pumps with a capacity of 150 gpm. each.

The skips at No. 2 Shaft dump the ore



LOCOMOTIVE AND TANK CARS

Ore gathering is done with Mancha storage-battery trammers (right). The cab is hinged and folds up so that the unit can enter a shaft cage for transfer to any desired level or to the underground battery-charging station. Tank cars, at the left, are used to remove slimes that settle on the bottoms of sumps at the mine pumping stations. The sludge is pumped into them and discharged by opening a valve upon reaching the surface. The cars have a capacity of 300 gallons each.

into a 200-ton overhead bin adjacent to the headframe. From this bin it flows in a steady stream to a 14-inch Traylor gyratory crusher with a Sheridan grizzly feeder. The crushed ore is elevated by a belt conveyor to a screen, the coarse going to a 4-foot Symons standard cone crusher and the wet undersize to a storage bin. The material from the Symons crusher passes to a set of Niagara vibrating screens operating in a closed circuit with a 5½-foot Symons short-head cone crusher. The screens are of ¼x1-inch mesh, and the final product is fed to a 2,000-ton circular concrete bin from which it is transported by a "jig-back" Leschen cable conveyor, with two duralumin buckets of 3-ton capacity, to concentrator bins on the opposite side of a gulch. An American Blower Company dust-collecting system is installed in the crushing plant and works efficiently.

Grinding is carried out by ball mills working in a closed circuit with DFX classifiers. Concentration is effected by selective flotation in pneumatic cells, and the concentrate is delivered to the Port of Santa Lucia by an aerial tramway for storage and periodic shipment to a smelter at Carteret, N. J. The ore boats in this service anchor outside the shallow channel, and are loaded by a fleet of two tugboats and seven lighters of 150 tons capacity. The company's power plant is located at Santa Lucia and consists of one 1,000-kw. and two 1,500-kw. generators directly driven by steam turbines, the boilers being fired with oil. The mine produces approximately 1,000 tons of ore daily and employs 1,000 men: 750 underground and 250 in the surface and service departments, which include the crushing plant, the concentrator, the power plant, the machine, electrical, and carpenter shops, the foundry, and the warehouse.

Native round pine is used for mine timbering, and the timber-framing plant is convenient to No. 3 Shaft. This plant also houses equipment for treating timber by the retort or pressure-cylinder method using Wolman salts. This service was inaugurated five years ago as an economy measure, and it has proved of importance not only in effecting savings but also in contributing to mine safety. Before it was introduced, timber had a life of from one to two years, but since then none has failed owing to fungus rot or termites. All timber except that for temporary use is given the pressure treatment.

Six Eimco-Finlay loaders are used for mucking out drifts and crosscuts. These units are powered by compressed air, and in limited cross-sectional areas go through all the motions of their larger counterparts which are operated by steam, electricity, or internal-combustion engines and which long ago made it possible to mine low-grade copper deposits in other parts of the world.

Mechanical ventilation was instituted at Matahambre many years ago and has a capacity of 135,000 cfm., three exhaust units, of 45,000 cfm. each, being installed over ventilation raises which provide outlets for the vitiated air. The air is taken in through the three shafts and passes through booster fans on the bottom levels in the case of No. 1 and No. 2 shafts. There it is divided as needed, rises through stopes to the upper working levels, and is then drawn out by way of the raises mentioned. There are smaller mechanical units for the local ventilation of dead ends, the air being carried to the faces by sectional tubing of galvanized iron or rubberized canvas.

Comfortable houses, water, and electricity are provided free to all employees; and the town of 4,500 persons enjoys all modern conveniences and sanitation. There is an up-to-date hospital; and a company store, including a bakery and a meat market equipped with the latest mechanical devices, sells at cost prices and contributes directly to the high morale of the organization. In fact, the mine is an important asset to the entire province, for the community represents a ready market for the agricultural products of the district.

An organized safety-first campaign, originally begun in 1928 and reinaugurated in 1936, has been very successful. Education and advertising are predominent features of it, together with energetic action by the management and staff based on recognition of the fact that safety is an operating problem. The organization claims a world record for continuous exposure to injury in underground mines without a lost-time accident, all departments having once worked for a period of five months and 22 days, representing a total of 1,451,704 man-hours, without an accident of that nature.

In short, mining at Matahambre is an engineering operation that has kept abreast of the times and that carries on original investigations in an effort to solve specific problems in the most logical manner. Different members of the staff, through contributions to the technical press, have passed on the results of this experience for the information of the industry as a whole.

References: G. L. Richert, *Mining Methods at Minas de Matahambre, Pinar del Rio, Cuba.* U. S. Bureau of Mines, Information Circular 6145, 1929. 18 pp.

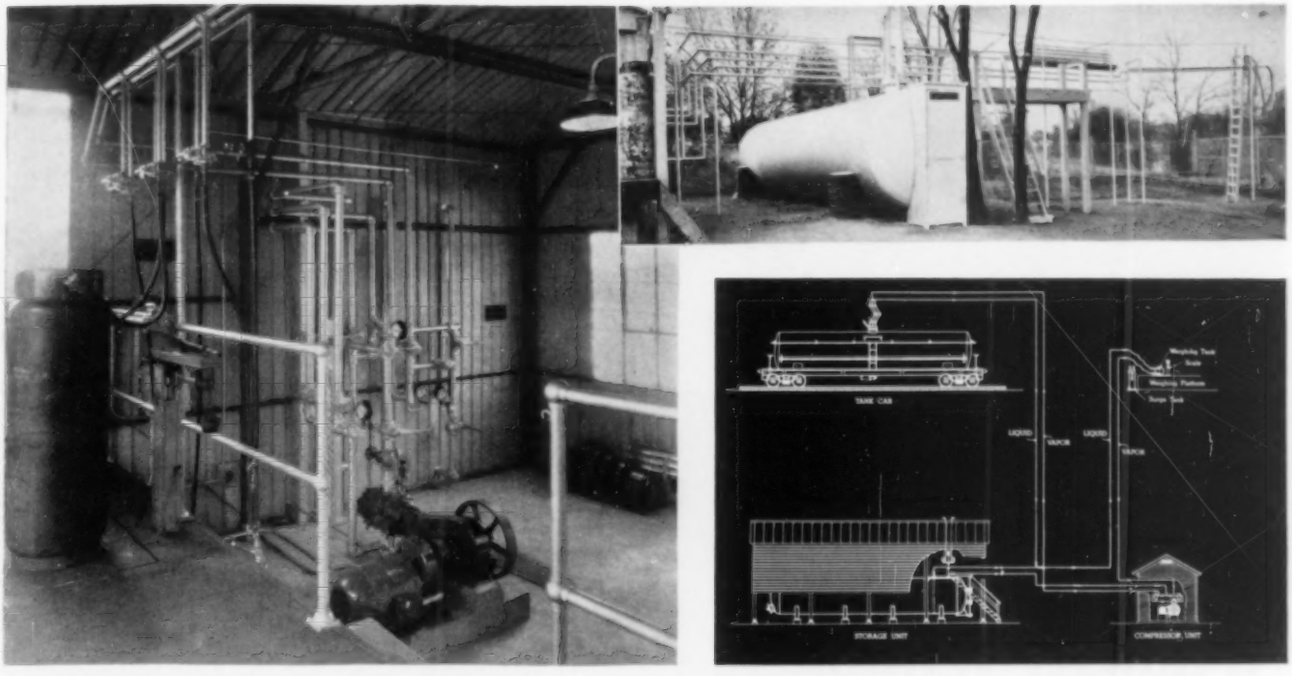
A. R. Kirchner, J. V. Galloway, and W. P. Schoder, *Milling Methods and Costs of the Minas de Matahambre, S. A., Concentrator.* U. S. Bureau of Mines, Information Circular 6544. 1931. 11 pp.

D. D. Homer and R. H. Cromwell, *Sinking and Equipment at No. 2 Shaft at Minas de Matahambre.* The Explosives Engineer. Vol. 11. No. 2. February, 1933.

L. T. Brown, *Copper Mining in Cuba.* Colorado School of Mines Magazine. Vol. 22. No. 11. November, 1937.

T. G. Murdock, *Seguridad Primero is Their Motto.* The National Safety News. Vol. 38. No. 5. November, 1938.

G. L. Richert, *Filling Stopes With Mill Tailings.* Engineering and Mining Journal. March 2, 1929.



LAYOUT AND FEATURES OF BULK PLANTS

At the top right is the storage tank of a plant used for unloading butane in quantity. Containers for liquefied hydrocarbons range in capacity from 13,000 to 18,000 gallons and more and are fitted with cooling and condensing coils so they can be emptied for inspection. This type of plant can be built complete with carbureting and mixing apparatus and with a gas tank to deliver the fuel direct to the distributing system. Immediately below is the flow sheet of a typical anhydrous-ammonia plant. At the left is an inside view of a compressor house designed for handling liquid hydrocarbons. The unit at the right is a 2-stage Type 30 machine such as is used to provide air for transferring chlorine and the like from tank cars to storage tanks, and in the foreground is an ER 4x4 horizontal gas compressor. The latter is part of the system by which propane, etc., are reduced to gas and stored under pressure in this case in large cylinders, one of which is at the left.

Handling and Storing Liquefied Gases in Bulk

IT IS a well-known fact that the cost of handling and transporting products in small lots is sometimes out of all proportion to bulk shipments. This is especially true of gases such as propane, butane, carbon dioxide, anhydrous ammonia, chlorine, etc., that must be stored under relatively high pressure to keep them in a liquid state. It is common practice to carry these gases in metal cylinders that weigh much more than their contents and which, with the exception of a few 1,000-pound flasks, have a maximum capacity of but 100 pounds. Although these containers are entirely satisfactory for moderate-sized operations, they are obviously inadequate where the regular consumption is large. However, the practice has persisted, despite the availability of tank cars for the transportation of industrial liquefied gases, and is probably attributable to the fact that the bulk handling and storing of each of them presents its own engineering problems and needs special equipment. We are told that it is no more difficult or dangerous to take such gases from properly built bulk plants than from pressure cylinders. Plants of this type are now in service and have been designed and constructed by the Blaw-Knox Company and others.

Although the structural details and apparatus of the gas unloading plants vary with the product handled, the transfer from the tank car to the storage tank is effected by creating a pressure difference between the two containers by means of compressed gas or, in the case of chlorine and the like, with compressed air. Gravity flow is not possible, because the regulations of the Interstate Commerce Commission do not permit bottom outlets in cars of this type. The pressure is applied to the free surface of the liquid and is ordinarily supplied by a machine of the piston type which, together with the extensive system of piping, valves, and other essential equipment, is chosen to meet the particular service needs.

The rate of transfer from the car to the storage tank, or vice versa (the operations are reversible), varies with the pressure and, if the liquid happens to be propane or butane, with the time required to cool the fuel after it has passed through a gas compressor. The latter is a necessary part of a plant that is designed for hydrocarbons. After all the gas in liquid form has been forced out of the tank car, the vapor inside of it is pumped out until the pressure in the car is at a point slightly above atmospheric, thus assuring maximum recovery of the high-pressure gas. If the product handled is explosive or inflammable, the tank is fitted with safety valves and with special check valves to stop the flow in the event of accidental breakage anywhere in the system. Furthermore, all motors used are of the explosionproof type, and the lamps are vaporproof.

The storage tanks are built in accordance with the A.S.M.E. Code and the laws of the State in which the bulk plant is to operate. They are welded and stress relieved in one piece, all seams are examined by X-ray, and they are tested at twice the pressure to which they will be subjected in service. Either single- or double-tank storage is provided, depending upon requirements. The units vary in size, the smallest for chlorine having a capacity of 7,500 gallons and the largest for liquefied hydrocarbons, 18,000 gallons, and more in special cases. However, they are generally big enough to take the contents of one tank car with room to spare to prevent overflow. Standard tank cars for transporting ammonia, propane, butane, etc., hold approximately 10,000 gallons each, and by the ruling of the Interstate Commerce Commission shall, when filled, contain not more than from 85 to 90 per cent of their total carrying capacity. On that basis, the storage tanks of the bulk plants are designed with an ample margin of safety.

CREATOR-CURATOR IN HIS WORKSHOP

Clem or "Pop" Shaffer, retired contractor, with some of his strange creatures in process of evolution. He is pointing to a 1-legged monkey while an octopus looks on.

Wooden Wonderland

Jim Kirby

KING OF BEASTS

The ferocious creature at the top, right, exemplifies Clem Shaffer's imagination at its best. Except for the teeth, this caricature of a lion is just about as it grew in the tree from which it was taken. Various superfluous limbs were removed, and saw and sandpaper were liberally used. The galloping ghosts at the bottom would give anyone a start if one chanced upon them on a moonlit night. It can be seen that their twisted forms are little-altered portions of trees that the elements have sculptured.

YOU would hardly say that the zoo of Rancho Bonito nestles among the high hills of Mountainair, N. Mex. Rather, you would say that it bristles. In fact, it is truly awesome. Even in the section where the people have been looking at these strange creatures in wood for some time, they are still a source of wonderment. A collection of real animals in such a setting could not be more of a novelty than the odd assortment of make-believes that the Rancho Bonito shelters. All these wooden creatures have been "captured" from the twisted and gnarled woodland of the surrounding mountains. Scorning carving and similar means of alteration, their creator and keeper collects them as he visions them in their native state.

It takes more than an ordinary man to see an animal in a tree that has been bent and twisted by the elements. But Clem or, better, "Pop" Shaffer is not an ordinary

STONEWORK

The caretaker's home, below, probably gives that man and his family nightmares after a heavy supper of native *chile*. For ornamentation, use has been made of split rocks chosen especially for their coloring. At the right is the fireplace in the hotel at Mountainair that Shaffer, as he has put it, has turned over to his wife to get it off his hands. The small wooden animals on the mantel are designed to arouse the curiosity of the guests—a sort of "teaser" to give the proprietor of Rancho Bonito Zoo an opportunity to publicize it.

person. One day he came upon a tree that had a growth circling a part of its 2-foot trunk. Many persons had seen it only as a tree, but Pop Shaffer saw a lion's mane in the malformation. From a section of this tree he has constructed a magnificent king of beasts. By leaving on it advantageously located limbs, he gave the animal legs. Another scraggly branch was left to form a twisting tail. Judicious use of a saw gave the lion a yawning mouth in which ample teeth have been set, while the stumps of limbs serve as eyes. The result, realistic if not inviting, may be seen in an accompanying picture.

In similar ways, all the members of this unique inanimate menagerie have come into being. Many of the figures have been stripped of bark, while others have been provided with an apparent coat of hair by sandpapering the bark. Mouths and feet are generally shaped with a saw. If cut green, the wood is allowed to dry in the open for eighteen months, after which it goes to the "laboratory" for transformation. Sandpapered areas are coated with linseed oil and later with shellac or varnish, depending upon whether the specimen is to be stationed indoors or out.

Clem Shaffer is a man "close to 60." Which side he is on is his secret. Two years ago he retired from the contracting and machinery business and set about developing the Rancho Bonito zoo. Pop, as he is known all over New Mexico, is bald, hardy, a continuous pipe smoker, and has all the enthusiasm of a boy of twelve for his hobby. Shell-rimmed glasses hold up a dilapidated hat, and well-worn overalls are a part of his regular attire.

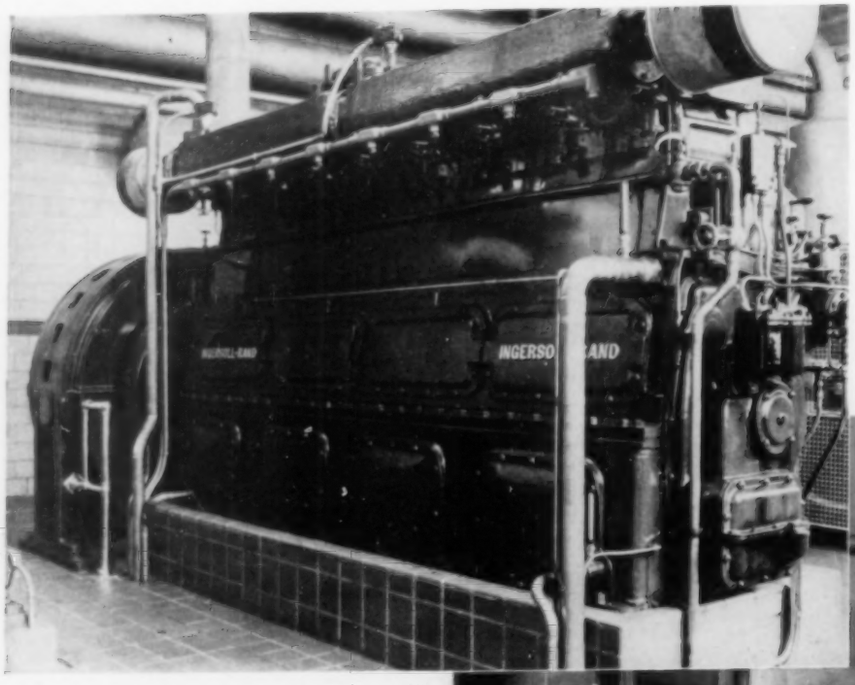
In two years he has spent $4,000 on his unusual avocation, which he describes as making something useful and beautiful out of worthless materials. He estimates that it will take him seven years to complete his rustic zooland. In the end, he expects to have 500 or 600 animals disposed on twenty acres of his ranch, and all of them as nearly as possible with natural backgrounds. It will be open to the public, probably free of charge. Last year some 12,000 persons journeyed to Mountainair, 50 miles southeast of Albuquerque, to view the results of his imagination and his handicraft.

It all started when Pop was eating his lunch under a juniper tree one day. He happened to look up at a nearby tree and saw in it a calf "as plain as day." Henceforth, he let his imagination run, and all who have seen the fruits agree that it runs like an endless belt. Pop does things with rock as well as with wood, and no small part of this strange Rancho Bonito are its rock buildings. The house he constructed for his caretaker no doubt gives that man and his family nightmares after an extra heavy supper of native *chile*. Its exterior is decorated with odd figures ranging from the lowly fish to the Democratic donkey. There is another species, the ordinary New Mexico pack burro. For the benefit of the uninformed, Pop explains that the latter has a lengthy expanse of back, while the political donkey is more closely coupled. Having done considerable research in constructing the animal kinsmen, Pop considers himself an authority on donkeys.

On either side of the building's doors are rocks that have been worked into likenesses of Uncle Sam. The resemblance is recognizable, if you have been forewarned. No rock that went into the walls and chimney has been changed. That used for decorative effects has been split to provide the desired thin sections. All have been selected with particular attention to their coloring, and to preserve this they are coated with varnish.

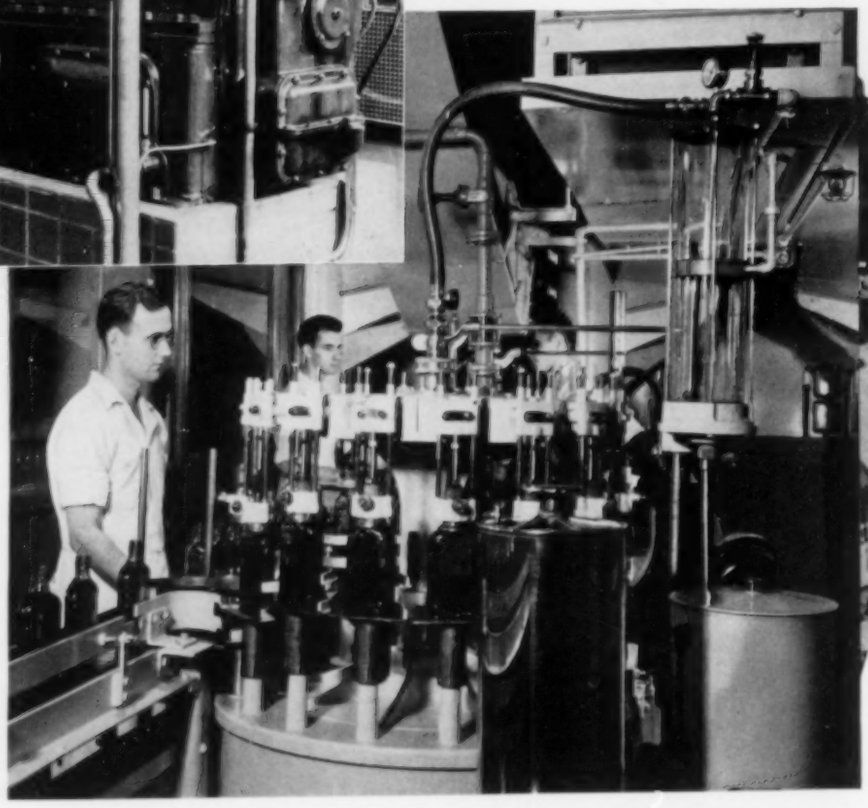
Like most people who ride a hobby, Pop rides his hard. He often does a good 12-hour turn at it when he isn't busy looking after his several farms. He owns the hotel where he lives, but has turned the management of it over to his wife. "I wanted to get it off my hands," he explains. The creator and proprietor of the Rancho Bonito zoo frequently tells tourists that the animals they see there are those that were left out of the Ark. He plans to open up the display this year as a sort of sideshow to the state's Coronado Cuarto Centennial celebrations that are planned for various localities in New Mexico. There are now between 200 and 300 animals on the place; but Pop explains that the menagerie is far from completed. In fact, he predicts that it probably won't be finished in the seven years he originally allotted for the task. Whether or not this bizarre exposition will ever be fully constructed depends upon how long Pop Shaffer lives. He has two sons, but neither shares his zeal for animal forestry, although between them they exemplify the two sides of his nature. One of them is a well-known New Mexico muralist, and the other is an Albuquerque contractor.

Modern Distillery



DISTILLERY EQUIPMENT

Below is shown one of the high-speed bottle-filling machines. The cylinder in the foreground is a filter that insures high clarity of the finished blend. The entire rectifying and bottling plant operates on power from a diesel-engine generator, making it independent of the steam-generating equipment. The diesel generator set is shown at the left. It consists of a 460-hp., 7-cylinder Ingersoll-Rand Type S diesel engine direct connected to a 320-kw. generator.



THE town of Lawrenceburg, Ind., situated on the Ohio River between Cincinnati and Louisville, has long been a favorite seat of whiskey distillers. More than 130 years ago the first of these, Dunn & Ludlow, established there a plant with a weekly output of two barrels. On almost the same spot now stands the huge distillery of Joseph E. Seagram & Sons, Inc., which produces daily more than 1,000 barrels of whiskey and grain neutral spirits for blending.

It is a far cry from the small pioneer distillery with its crude milling, mashing, fermenting, and distilling equipment to the present plant with its graded-grain bins, humming mills, and pressure cookers; with its battery of domed steel fermenters, 4-column spirit stills, and by-product recovery plant; with its vast warehouses full of maturing spirits, its blending department containing stainless-steel tanks and multiple filters, and its array of swift-moving bottling lines. Indeed, the entire cycle of whiskey production is encompassed within that historic locale.

At first sight it strikes one as revolutionary that diesel power should have invaded an industry given over to moderate and low-pressure steam consumption. Process steam is usually obtained from the exhausts of the prime movers; and until recently that source of energy for mashing and distilling seemed satisfactory. Inasmuch as an excess of process steam is required for the various operations, the obvious thing would be to develop electric power by turbogenerator sets or engines interposed between the boilers and the distilling equipment.

It has been the common practice in the past to establish a series of steam-pressure levels in the distillery in keeping with the characteristics of the various machines and apparatus. That is, the turbines were supplied with steam at boiler pressure, while the cookers and auxiliaries used the turbine exhaust; the stills, driers, and heating system the secondary exhaust; and the evaporators in the by-product plant the residual low-pressure steam. To depart from this schedule was to abandon efficiency and economy. At the Seagram plant there has been effected a compromise in favor of quality.

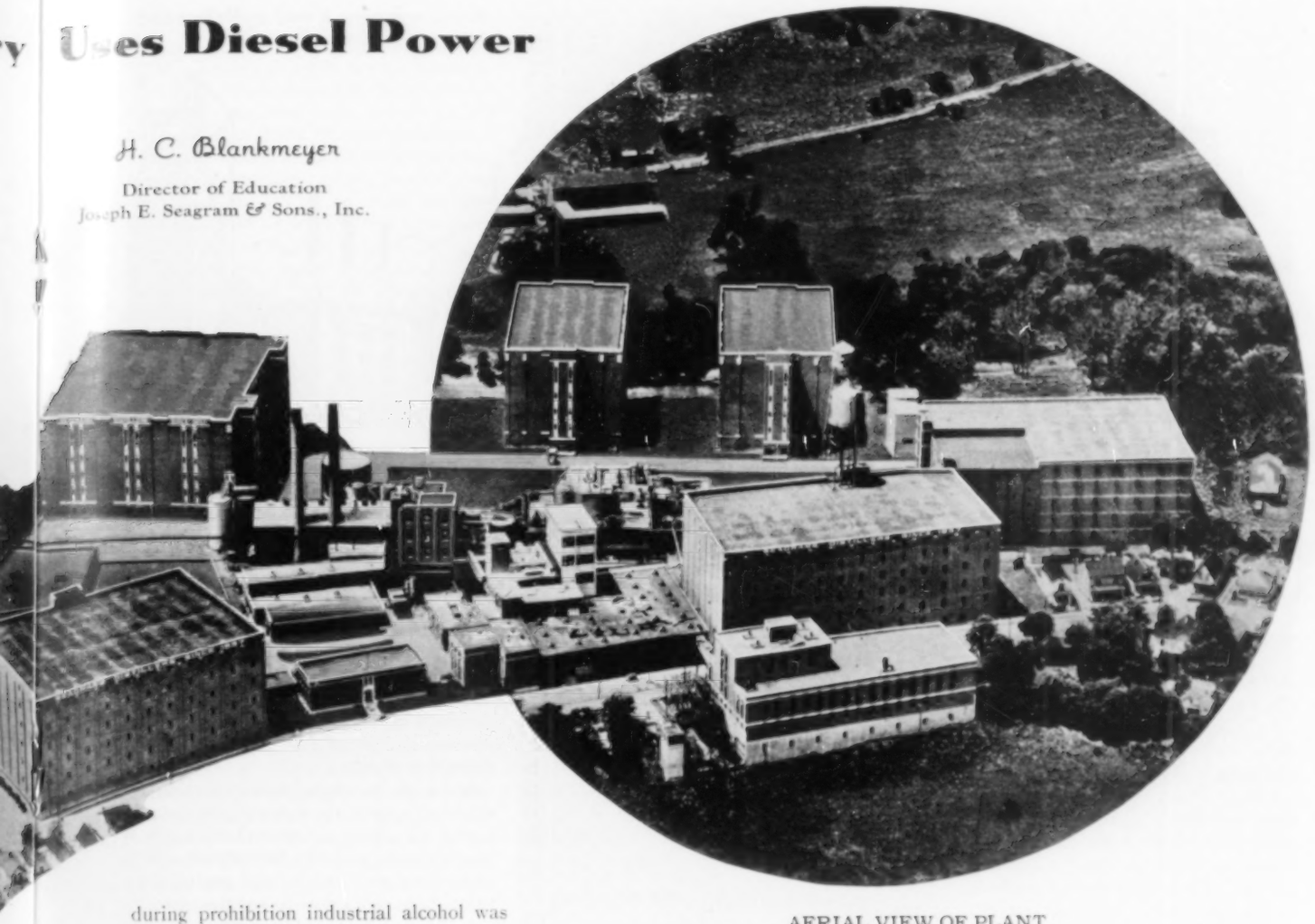
Whiskey has become a quality product: it is made and marketed on that basis. In former days, when it was sold directly from the barrel, or passed through the hands of an independent blender, there was no incentive for a distiller to employ refined methods of manufacture. There were few national brands, and almost no marketing problem. Nowadays, however, when production must be geared to Federal regulation, when the industry has become highly competitive, and when the lay public is being continually educated through the agency of consumer appraisal associations in the art of buying, the watchword is quality.

The stressing of quality has emphasized the need for research. The beverage-alcohol business in the United States is a newcomer in industrial research. It suffered the crushing blow of prohibition just when the post-war boom ushered in an era of scientific aid. Fortunately, the Seagram company, with its Canadian plants, was able to keep abreast of the times. It took advantage of developments in fermentology and distillation by applying them to its own problems; and it surveyed the field for strategic locations for distilleries when repeal should come. Lawrenceburg was one of its choices. On the site selected there had been a distillery for more than a century; and even

Uses Diesel Power

H. C. Blankmeyer

Director of Education
Joseph E. Seagram & Sons., Inc.



AERIAL VIEW OF PLANT

The Lawrenceburg, Ind., plant of Joseph E. Seagram & Sons., Inc. The distillery proper occupies principally the central group of buildings. Surrounding it are large warehouses in which 615,000 barrels of whiskey is maturing.

during prohibition industrial alcohol was being produced there.

Accordingly, when repeal in 1934 once more made large-scale operations legal and profitable, and when there was a sudden rush of inexperienced purveyors who expected to make a killing in the whiskey market, the consolidated firms resumed business under strained conditions. Consumer demand was great; available stocks were low; skilled personnel was hard to find; and, worst of all, manufacturers of distillery equipment were equally handicapped by a lack of technical design data.

Distillers were not long in realizing the necessity of stressing quality, because quality is the prime sales factor in a direct-consumer product that depends on its bouquet and taste for its market. The slightest contaminant or foreign substance will totally destroy the balance of the best blend. Similarly, variations in equipment operation will result in a finished product that lacks uniformity. The manufacturer, then, is faced with two distinct problems: the generation and use of pure steam for mashing, distilling, and sterilizing, and the installation and maintenance of accurately controlled machinery to insure uniformity. And here is where the diesel engine plays its important part.

Steam for the critical processing operations comes directly from the boilers, to that extent cutting down the supply available for the production of electric power. At the same time the complex distilling equipment is controlled automatically from master panels, and this calls for a source of electrical energy that is both reliable and independent of the main generating station. Literally scores of pumps, driving mechanisms, valves, conveyors, blowers, and meal-handling devices are operated by explosion-proof motors which, in turn, are actuated and controlled by automatic, electrical regulators. These require a dependable source of power, which the diesel engine furnishes.

The blending and bottling-plant operations—involving agitation, filtration, pumping, conveying, high-speed filling, capping, labeling, and case sealing—are performed exclusively by electric power and must be carried on independent of the distillery for the reason that those operations are several years out of phase with the mashing schedule because of the period of whiskey maturation. In this way the distillery can be shut down without affecting the bottling division. Again it is the diesel-generator set that provides the power which otherwise would have to be purchased or manufactured uneconomically.

The Seagram company realized the advantage of such an arrangement and set up a Type S, 460-hp. Ingersoll-Rand diesel engine, direct connected to a 320-kw. Elliot generator, to supplement a 750-kw. turbo-generator and a 450-kw. Unaflow engine generator set already in service. The original intention was to use the diesel equipment only at peak loads and as a standby in cases of emergency. However, since its installation it has run almost continuously. Besides achieving the two purposes outlined, it has contributed substantially to efficiency and economy by leveling out the power-production curve, by permitting boiler shutdowns for regular maintenance, and by making the blending and bottling operations independent of the steam-generating plant. Thus a leading distilling company has found that the diesel engine and traditional steam power can be made to work together to advantage.

BETTER MINE VENTILATION

ONE of the principal problems the engineer has to contend with in developing a mine is that of adequate ventilation. As depth increases, the more important it is to provide the men with life-giving and vitalizing air. Temperatures in passageways and stopes are often far from comfortable. Despite the fact that the miners grow somewhat accustomed to these unfavorable conditions, better ventilation increases their efficiency

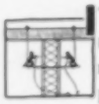
One of the most recent contributions to improved mine ventilation is the equipment by which circular shafts 36 and 48 inches in diameter can be bored underground. These holes are generally located in the "hot spots" of a mine, where otherwise dead air can be circulated by connecting two or more levels. It has been proved that a bore hole, with its smooth walls, is definitely superior for this purpose to the conventional type of raise, which is generally lined with timbers that act like a series of baffles and retard the air flow.

An important advantage of this system is that it permits putting down a ventilation hole prior to opening up lower levels, making it possible to start production there as soon as the lower levels are connected with the ventilation shaft. The old practice was to drive a drift at a lower level, after which it was necessary to open a raise to the next level above to obtain circulation of the air. Production was frequently delayed until this raise was completed.

The boring of these circular shafts is done by means of a Calyx core drill. This machine cuts an annular groove around a central column or core of rock. The cutting medium, chilled shot, is fed to the cutting face of the bit by flowing water, which then rises and carries the rock cuttings with it. At a point above the core barrel the velocity of the water is reduced and the suspended cuttings settle into a sludge receiver. This circulation system keeps the bit running freely.

The actual cutting is done by rotating the tubular bit or core barrel, which grinds the shot beneath its bottom edge, thus setting up an abrasive action. From 50 to 60 rpm. per minute has been found to be the most practical speed of operation. After a suitable section of core has been cut, it is blasted loose with a small charge of explosive and brought to the surface by means of a core-lifting device. The core is then released from the lifter and the boring tool returned to the bottom of the hole to begin another cut. It has been found that holes from 36 to 48 inches in diameter are the most practical for underground operations. However, there are machines capable of boring holes up to 72 inches in diameter to depths of 1,000 feet and more.

CONSTRUCTION FOR DEFENSE



IT IS difficult for the layman to understand why it will take many months, or even several years, to provide an adequate military defense for the United States. He is prone to think of the task merely as one of schooling a prescribed number of men in military tactics and providing them with the essential arms and equipment. He knows that our resources are vast and that our industries are capable of accelerating to high gear in a short space of time, and he thinks that our huge plants can turn out uniforms, rifles, clothing, tanks, airplanes, and munitions with the dispatch of sausages.

Actually, of course, the building of a competent and adequately equipped military machine is a complex process. To do the job well, the whole nation must be dedicated to the task. Armies must be housed and fed, given medical care, and taught a thousand and one things besides the manual of arms. Furthermore, they must be rendered mobile by organizing and equipping them so that they will function effectively and be adequately provided for while moving a hundred or more miles a day. Battles aren't fought adjacent to barracks.

We contemplate spending $12,000,000,000 on our immediate military-and-naval preparedness program; but we do not propose to spend a large part of this money until 1942, and much of the naval budget will not be expended until 1943 and 1944. One of the first steps in the program is to build training camps and to enlarge industrial plants so that they can cope with wartime demands. This is a job for which the construction industry is fortunately well prepared. The Associated General Contractors of America, Inc., has made a survey of the situation and issued a favorable report through its managing director, Edward J. Harding.

Although the ultimate cost of construction incidental to the defense program cannot be accurately estimated, it is believed that approximately $1,500,000,000 will be spent between now and the end of 1941. While this is a large sum, it represents only one-eighth of the present annual capacity of the building industry. The total volume of construction in the country in 1939 was a little less than $10,000,000,000, and there will probably be a small decrease in 1940. This means, according to the A. G. C. report, that there will be an unused capacity of more than $2,000,000,000, or much less than the defense program will call for.

The survey disclosed that there are 2,600,000 construction workers available, as well as enough competent, adequately financed contractors to handle all the work that may have to be done. The latter own equipment that is conservatively valued at $500,000,000 on the basis of its depreciated condition and not its first cost. It was pointed out that the continual improvement of equipment by manufacturers increases the productivity of the building industry. It is expected that much of the construction will be of a kind that large numbers of contractors can perform easily.

Although the main defense program has not started, the construction industry has already proved that it is capable of full coöperation with the Government in work of this kind. The Navy's $16,000,000 airbase program in the islands of the Pacific is approximately ten months ahead of schedule and is costing less than was estimated.

Sleuthing for Compressed Gas Flasks

THE American public is continually on the go. The average city dweller is restless and moves about every two years. It is not unusual to find a man who has lived in five or six different states in his lifetime. Surprisingly few residents of any United States city live in the place of their birth. Business firms that address letters from supposedly up-to-date mailing lists find that an amazingly large percentage of the mail is returned, stamped "Out of Business" or "Moved, Left No Forwarding Address."

This mass migration has at least one direct influence on the compressed-gas industry: hundreds of persons take such flasks with them when they move. Because of this practice, several producers of compressed gas engage Skip Tracers Company of New York to find the individuals who make off with their cylinders. In addition, the company also locates missing debtors, credit dodgers, and other absentees. These persons are called "skips" because they depart and leave no forwarding addresses. Seven out of every ten sought are found.

During its sixteen years of existence, Skip Tracers Company has had much experience in locating people who fail to return cylinders. While they are of no particular value to most persons, they are sometimes sold to scrap-metal dealers. This is but one of the many practices resorted to by skips. Some of them make small down payments for goods and have merchandise delivered to them. Then they clear out without even the formality of paying their rent. When they make their getaway, a number of search methods, that have been reduced almost to a science, are used in tracking them down.

For its commercial activities, Skip Tracers Company maintains a highly trained research department. Here thousands of records are kept of persons involved in lawsuits, bankruptcies, judgments, wills, leases, incorporations, partnerships, deaths, etc. Here, too, are filed names and addresses of unlisted telephone subscribers. This mass of data furnishes valuable clues to be followed up by outside investigators. The department contains accurate records of approximately 4,000,000 people who have been, are being, or may be sought. Private and public agencies reported 869,432 individuals missing in the United States in 1939.

But there are other sources of information open to tracers. Moving-van companies and storage warehouses frequently coöperate, as well as insurance agents and milkmen, who often provide the hints that prove to be the key to the solution of a case. Each, of course, is handled separately; and the routine facts in the index system and the leads gathered by outside operatives make it extremely difficult for anyone to disappear. Statistics show that the chances are four to one against any person making a successful fadeaway.

NEVADA HIGHWAY STRIPER

Views showing the complete assembly and the applicator mounted on a separate carriage in front of the truck. Compressed air is used both to agitate the paint in mixing it and to spray the stripes on the road.

New Multiple-Stripe Road Marker

THE Nevada State Highway Department recently placed in service a machine that can paint up to three traffic stripes on a road simultaneously. Where two or three lines are put down, separate colors may be used for each. The spraying equipment is in a small, 4-wheel, pneumatic-tired vehicle that is pushed in front of a 2½-ton truck. Three spray guns are mounted between disks which are set in a vertical position and which control the width of the stripes. A man riding this carriage, or applicator, steers it and also controls the spray guns. Accurate steering is accomplished with the aid of a long arm or target that projects in front of the applicator and that is kept right on the line it is desired to follow.

Compressed air for operating the spray guns and for agitating the paint to mix it is furnished by an Ingersoll-Rand Type 40, air-cooled machine having a piston displacement of 79 cfm. It is mounted on the truck, which also carries three pressure paint tanks—two of 60 gallons capacity and one of 30 gallons—and is driven by a gasoline engine. The apparatus is used to paint a continuous white center line, with a yellow stripe on either or both sides of it in restricted areas to serve as a "no passing" warning to motorists. In addition to flagmen, the outfit requires a crew of three: a truck driver, an applicator operator, and a paint mixer and compressor attendant. The assembly was designed and built in the Nevada State Highway Department shops.

Machine Heats and Quenches Inner Walls of Metal Cylinders

FOR heat-treating the inside diameters of metal cylinders and bores, Budd Induction Heating, Inc., a subsidiary of the Budd Wheel Company, has developed equipment that heats and quenches the work with one set-up. Heating is effected by electrical induction, and the area treated and the degree and depth of hardness can be controlled within exceedingly close limits. A machine of this kind is shown in the accompanying picture, with the hub of an automobile in position. The entire operation takes only a matter of seconds, and is accomplished by lowering the head of the unit into the barrel of the hub, which brings the surface of the bore to a high temperature, and by introducing water under high pressure for quenching as the head is being withdrawn.

HEATS AND QUENCHES

Electrical-induction heat-treating machine with a "one-shot" type of head. It is being used regularly to harden the bores of automobile-hub forgings to 58-64 Rockwell C. In the past three years nearly 2,000,000 hubs have undergone this treatment in the Budd Detroit plant.

The new method is being applied on a commercially practicable scale in the company's Detroit plant, and is suitable for the heat treatment of cylinders of a wide range of sizes. The length of the bore determines the type of head to be used. For short lengths a "one-shot" head is adequate; but for work of considerable length, such as engine cylinders, a retracting head is required and this is drawn through evenly to assure uniform heating throughout. The machines are equipped for rapid changeover from work of one diameter to another, to vary the depth of hardness from thirty-thousandths of an inch to ⅛ inch and more, and to complete the cycle of operations in from one to three seconds.

An important factor of the process, according to Budd engineers, is that the outside diameters and all other unhardened areas can be machined—in fact, the machinable area can be determined with accuracy because the extent, depth, and degree of hardness are subject to precise control. Besides, local heat treatment after machining is possible. Further claims are that the high speed of heating not only prevents decarbonization but, in combination with well-nigh instantaneous quenching, reduces oxidation to a minimum and, with special provision, even eliminates it. The company has announced that it is prepared to design and to produce parts with bores hardened by the new method, or to treat finished cylinders, etc., shipped to its plant. The process is applicable to all ferrous materials that can be hardened, drawn, tempered, annealed, or normalized, as well as to gray iron such as is used in many engine cylinder blocks, to cast iron, and to other metals of simplified analysis.

Molasses-Topped Roads

IN AN attempt to make use of the unlimited quantities of by-product molasses from the 150-odd sugar mills in India, the Imperial Institute of Sugar Technology has been experimenting with it since 1935. Recently, at the seventh convention of the Sugar Technologists' Association, it was announced that Dr. H. D. Sen, biochemist of the Institute, has perfected a process for the conversion of molasses into a resinified compound suitable for use as a road-surfacing material. According to *The Punjab Engineer*, the fluid is first dehydrated and progressively thickened until it can be drawn into strings at a temperature of 275°F.; second, the mass is acidified until its solubility is reduced to a minimum; and, third, a mixture of coal tar and asphalt (both of which are available in ample quantities) is added in the presence of an acid. Three grades of molasses road tar are made: No. 1, which is liquid and serves as a seal; No. 2, which is in a form suitable for premixing; and No. 3, which is hard. Service tests have shown that roads surfaced with the new product have the same load-carrying capacity as macadam roads treated with tar.

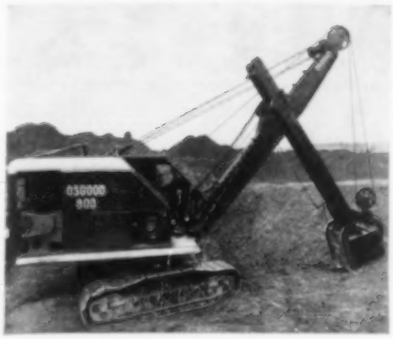
Hidden Pipe Lines Do Not Slow Up This Power Shovel

POWER-SHOVEL operators have been relieved of one great worry by the introduction of what is called the WTP Pipe Anticipator. The apparatus can be attached to any type of excavating, pushing, or boring machine and easily transferred from one to another. It is an automatic sound-signaling device that warns the operator when his bucket is approaching underground service pipes or cables. The value of this is obvious, for it not only prevents him from damaging such obstructions but enables him to go on digging until he is close to them, thus saving the cost of hand labor that ordinarily represents a considerable item on jobs of this kind.

The instrument, as the illustration shows, is mounted in the cab of the shovel in line with the operator's head. It is protected by a weatherproof cabinet and provided with three control dials: one for testing—reproducing the actual sound made when nearing a pipe; another for adjusting the circuit to compensate for varying soil conditions and for regulating the unit's sensitivity; and the third for controlling the volume of sound as determined by the operator's hearing. The signal is continuous, growing louder as the bucket approaches a pipe, and is transmitted either by a loud speaker or by earphones. There is a snap switch for starting and stopping, and the standard battery and generator on most excavators are sufficient to supply the necessary current. In addition to the battery connection, 200 feet of flexible cable is furnished in order to make the ground connection.

Before the Anticipator was put on the market by the Wallace & Tiernan Products, Inc., it was tested by a public-service company which used it in digging 140,000 feet of trench and manholes. In the course of this work, the machines, it is claimed, each excavated from 70 to 180 cubic yards of material a day in highly congested districts and uncovered more than 6,000 pipes and wood-encased, lead-covered cables. The pipes ranged from ½ inch to 24 inches in diameter and were made of steel, iron, copper, brass, and lead. Some were rusty, some bare, and others were protected by a coat of tar; but the detector gave warning of the presence of all of them.

Power Shovel Controlled by Air Clutches



WITH its latest power shovel—the Type 80—The Osgood Company has introduced a departure in heavy excavating machinery. The new shovel features air-operated clutches that control all its movements and make, it is claimed, for exceptional smoothness, ease, and economy of operation. Air is supplied by a 2-cylinder compressor driven from the end of the engine shaft, and air valves are of the metering type that permit the man in the cab to apply the clutches at any desired speed and enable him to spot the dipper for truck loading without sudden starts and stops. The unit is provided with large, reserve air receivers, and traps are placed in the air lines to assure a supply of clean, dry air.

The swing clutches are of the single-disk, heavy-duty type; the hoisting and crowding clutches are of the outside band type; and the retract clutch is a standard twin-disk, heavy-duty unit. All are actuated by single-acting air cylinders, thus eliminating trouble with packing glands. The shovel has a pneumatic swinging brake that can be used as a traveling brake when it is taking up a new position; and steering is accomplished by means of air cylinders which disengage the steering clutches and engage brake bands. All valves and levers are within convenient reach of the operator who, by reason of the pneumatic clutches, can control his machine with precision and therefore with an increased measure of safety to pitmen and truck drivers. Complete details of the Type 80 have been published in a 30-page catalogue that can be obtained upon request from The Osgood Company, Marion, Ohio.

New Ventilating Duct

FOR exhausting dust, gas, air, etc., Hersey & Company, Inc., has introduced a flexible ventilating duct of a rubberized fabric reinforced with wire arranged concentrically and held in place by an inner and outer rubber coating. It is marketed under the name of Flexaust and made in 30-inch sections for elbows and in greater lengths ranging in diameter from 5 to 24 inches. In the case of permanent installations, the joint consists of a metal ring into or over which the ends of the tubes are slipped, taped, and cemented with materials which the company is prepared to supply. For demountable connections there is an airtight clamp held by a single screw. Our illustration shows a duct 10 inches in diameter and 20 feet long with one end plain and the other fitted with a coupling.

Plating Cylinder Bores

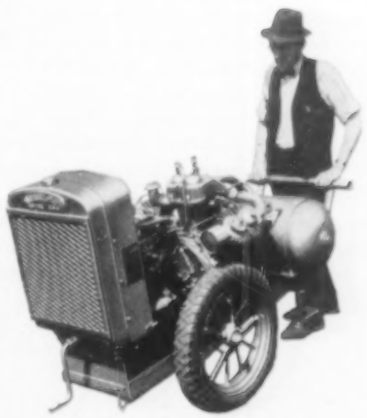
THE British Journal of the Institution of Automobile Engineers gives an account of a Swiss patent that has for its object the coating of the inside surfaces of light alloy cylinders with a thin layer of harder, wear-resisting metal. For this purpose the cylinder is fixed on top of a vertical hollow spindle which is rotated at high speed. Within the latter is a journal which carries a small crucible with an outlet on one side near the bottom. Molten metal pouring down into the crucible is thrown against the inner wall of the cylinder by centrifugal action, the crucible being slowly lowered from top to bottom so as to assure complete coverage. It is claimed that it is possible by this method to obtain a thin, smooth film of fairly uniform thickness free from cracks and of good heat conductivity. Either a light alloy of greater hardness and higher melting point than the cylinder, or any harder metal such as cast iron or steel, can be used for this purpose.

Portable Compressors for Odd Jobs

FOR urgent and odd jobs that must be done here and there on construction projects, by public utilities, etc., Ingersoll-Rand Company has introduced a portable compressor that can be taken anywhere with little effort, leaving the larger machines free for the heavier, steady work. The D-60, as it is designated, is the smallest 2-stage, air-cooled unit the company has so far constructed, and is designed along the same general lines as its larger portables. It delivers 60 cubic feet of air per minute at a discharge pressure of 100 pounds, and is available in three models named the Utility, the Push-about, and the Deluxe.

The Utility has a steel base permitting it to be mounted directly on or to be built into the body of a service truck. Its overall dimensions are: length, 5 feet 8 inches; width, 2 feet 8½ inches; and height, 3 feet 2 inches. The Push-about has a turtle-back cover and roller-bearing wheels with pneumatic tires. It is 5 feet 8 inches long, 2 feet 8½ inches wide, and 4 feet high, and can easily be pushed from place to place by one man or transported by a light pick-up truck. The Deluxe is a trailer-type portable designed for high-speed towing. Including drawbar, it is 8 feet 10 inches long, 4 feet 10 inches wide, and 4 feet 8 inches high. The latter has a protective housing and built-in tool boxes.

All three models have the same unified engine-compressor plant embodying, in a compact arrangement, a radiator, intercooler, air receiver, and fuel tank, the last named being large enough for a day's work. The compressor was designed specifically for this service and, like the engine, has its own crankcase and lubricating system, as well as cooling system, thus eliminating the danger of gasoline vapors from the engine cylinder passing over into the compressor crankcase. The D-60's can be used in connection with the general run of air-operated tools and equipment such as rock drills, paving breakers, riveters, concrete vibrators, paint sprays, grinders, impact wrenches, etc., required for outdoor service. A list of these, together with the number of each that can be run simultaneously, is contained in a 6-page illustrated folder—Form 2688—which fully describes and illustrates the new portables. It can be obtained from the company's main office, 11 Broadway, New York, N.Y., or any of its branches.



EASILY PORTABLE

The Push-about model with its turtle-back cover removed. The latter serves both as a protection against the weather and as a means of locking the wheels against theft.

This and That

Early Engine Preserved

The Baldwin Locomotive Works has presented to The Franklin Institute, in Philadelphia, Pa., the first steam engine made by Matthias Baldwin more than a century ago. The original firm, Mason & Baldwin, was engaged in manufacturing rollers for printing presses. In 1829 its quarters in "Bank Coffee-House Alley" became too small and were moved to Minor Street. With the hand-powered machines in use, work could not be turned out fast enough to fill the orders, and Baldwin, then 34 years old, decided to make a change. Horsepower was tried, but found to be inadequate, so Baldwin designed and built a steam engine. It developed 5 hp., and was the most powerful machine of its type manufactured up to that time. It proved to be so successful that the company began making stationary steam engines. The first Baldwin locomotive was built in 1831.

* * *

Copper Plated Feet

Offhand, you would undoubtedly say "nothing doing" if your doctor told you he was going to copperplate your hands and feet to cure you of *dermatophytosis*—athlete's foot, in plain English. But you might do well to submit to the treatment, for it has the endorsement, according to a recent announcement, of the medical profession. Athlete's foot is a fungus infection and has been hard to deal with in the past because the source of the trouble is deep seated and difficult to reach by exterior applications. But by the new electrolytic process the fungicide is driven into the skin and down to the lower layers where the molds that are the cause of the infection are located. A solution of copper salt serves as the electrolyte, and a current of mild intensity suffices for the operation. According to the Ohio State University Research Foundation, "Clinical cures and improvement in cases of long standing have been reported by the scientists who developed and tested the device which is now available commercially for use by physicians."

* * *

Spoil Pile Forestry

Near Canton, Ill., the United Electric Coal Companies strip from 25 to 68 feet of overburden to mine the coal stratum underneath it. Such an operation creates enormous spoil piles, which are unsightly and unproductive. In an effort to correct this condition, the concern is carrying out a reforestation program, according to *Excavating Engineer*. Approximately 23,000 hard- and softwood trees have so far been planted. The aim is to transform spoil piles into forest areas and eventually to restore wild plant and animal life to the regions concerned.

* * *

Silver Linings for Cans

Every cloud, as we all know, is supposed to have a silver lining. If the war continues, and our supply of tin is cut off, cans also may have one, according to J. P. Gill, president of the American Society for Metals. Mr. Gill says silver plating would make cans more expensive, but considers it the most logical substitute for tin plating.

"What's he ravin' about? I've used a saw before."

* * *

Ducks Replace Wages

Four hundred workers in a tungsten mine near Hong Kong, China, are paid the equivalent of only eighteen cents a day in United States money, according to a report in *Mineral Trade Notes* by Consul John Bruins. "The company," he writes, "at one time experimented in paying higher wages, but found that the coolies only spent the extra money on opium, which lowered their working capacity. The company now gives the workers a duck dinner once a month. This is consumed on the premises, and is found to please the workers, as well as to improve their productive capacity."

* * *

Page Doctor Shush

The magazine *New Yorker* published the following in its July 20 issue: "This happened in a city in the west—wouldn't be fair to make it more definite than that. A little housewife was doing her breakfast dishes when the doorbell rang. A strange man was standing outside. He introduced himself as a member of the American Legion, and produced adequate credentials. 'I'm helping investigate Fifth Column activities. I'm told that you've seen armed men in this neighborhood—know anything about them?' She couldn't think what he was getting at for a while, then she remembered. Several weeks before she had mentioned, at a bridge party, that men were drilling in the neighborhood, making a terrible racket with their compressed-air guns and tearing up the street in front of her house."

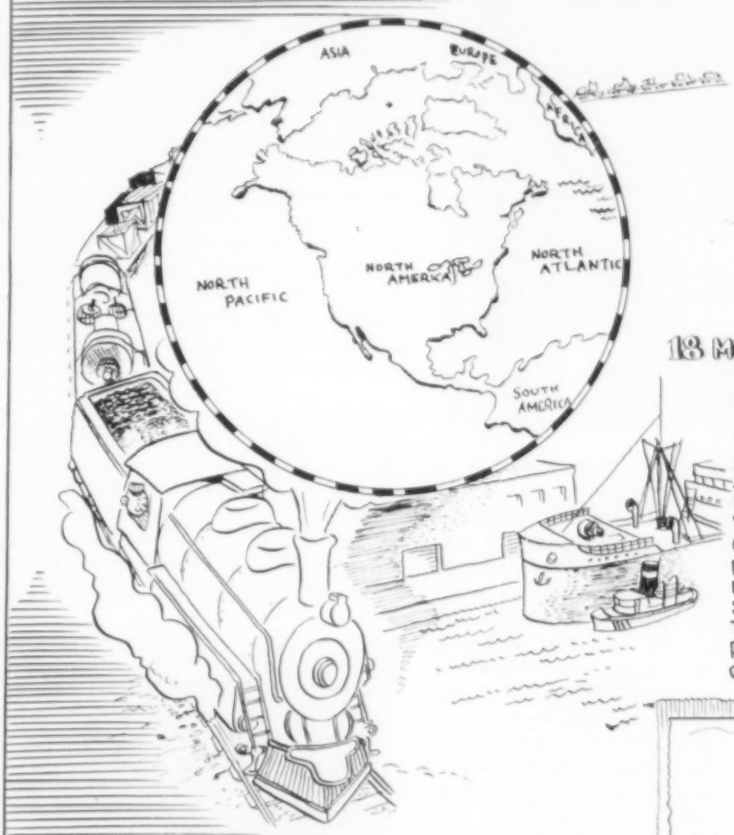
* * *

And So To Bed

In the not distant future we may literally "turn on the air" before retiring if a newly invented bed is generally adopted. Dr. F. K. Kirsten, an aeronautical engineer, is the inventor of this latest aid to slumber, which is calculated to rest the body and air condition it at the same time. The Kirsten bed consists of a metal box frame over which is stretched a material that is sufficiently porous to permit air to flow through it at a slow rate. Compressed air, under a pressure of 150 pounds per square inch, is stored in a cylinder in the basement of the house, is piped to the bed, and introduced into the frame through a reducing valve at a pressure of ¼ pound. The expansion cools the air, which rises around the sleeper and keeps him comfortable on hot summer nights. In winter an electric coil warms the air. A single special covering is provided. It is a double blanket, connected at the foot of the bed with small tubes that feed air into the intervening space. This air, reduced in pressure, passes out through the opposite end and around the sleeper's shoulders. By turning a dial at the head of the bed the user can select his temperature for the night. The inventor claims that such a bed will cost less than a conventional one and will make insomnia an obsolete word.

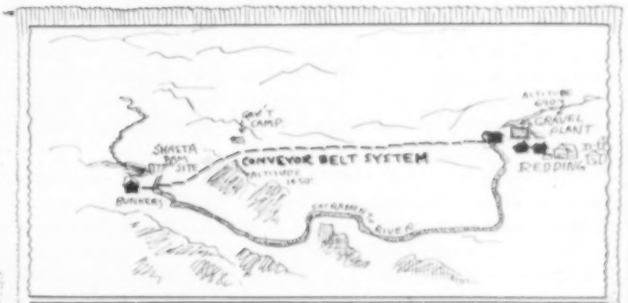
FEATS & FACTS

by ROBERT GLUECK '41



18 MONTHS TO DELIVER AND ERECT A DREDGE

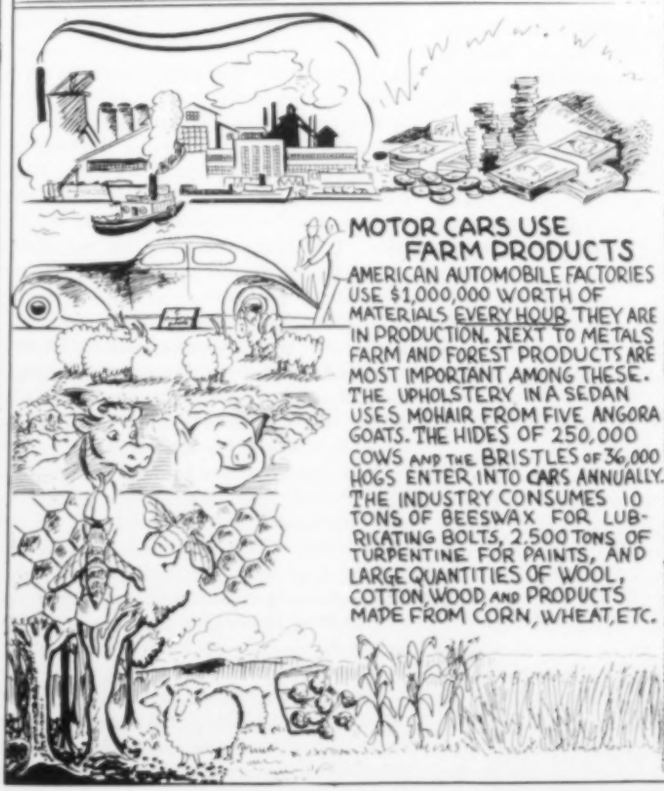
A BUCYRUS-ERIE $750,000 DREDGE TRAVELED ⅔ OF THE WAY AROUND THE EARTH TO REACH ITS DESTINATION IN SIBERIA. LOADED ON 75 FLAT CARS IN SOUTH MILWAUKEE, IT WAS SHIPPED BY RAIL TO BALTIMORE, THEN BY BOAT TO MURMANSK ON THE BARENTS SEA WHERE IT WAS AGAIN LOADED ON RR CARS AND ROLLED SOUTHWARD TO IRKUTSK. FROM THERE IT WAS TRANSPORTED BY WAGONS, SLEDGES AND CARTS OVER 200 MILES OF MOUNTAIN TRAILS TO KACHUGA, THEN DOWN THE LENA RIVER BY BARGES TO THE VITIM RIVER WHERE THE LOAD WAS TRANSFERRED TO SMALL BOATS AND CANOES FOR A 2000-MILE JOURNEY TO BODAIBO. FROM THERE A NARROW GAUGE RAILWAY WAS BUILT TO CARRY IT TO THE POINT OF USE, 11 MILES DISTANT....



LONGEST BELT CONVEYOR

AGGREGATES FOR THE CONCRETE IN SHASTA DAM, NEAR REDDING, CALIF., WILL BE DELIVERED TO THE MIXING PLANT ON A TEN MILE CONVEYOR SYSTEM. IT WILL CONSIST OF 25 ENDLESS BELTS EACH DRIVEN BY A 200-HP MOTOR AT A SPEED OF 550 FEET A MINUTE.

THE 5,610,000 CU. YDS. OF CONCRETE TO BE PLACED IN THE DAM WOULD MAKE A SOLID MONUMENT A CITY BLOCK SQUARE AND HIGHER THAN THE EMPIRE STATE BUILDING...



MOTOR CARS USE FARM PRODUCTS

AMERICAN AUTOMOBILE FACTORIES USE $1,000,000 WORTH OF MATERIALS EVERY HOUR THEY ARE IN PRODUCTION. NEXT TO METALS FARM AND FOREST PRODUCTS ARE MOST IMPORTANT AMONG THESE. THE UPHOLSTERY IN A SEDAN USES MOHAIR FROM FIVE ANGORA GOATS. THE HIDES OF 250,000 COWS AND THE BRISTLES OF 36,000 HOGS ENTER INTO CARS ANNUALLY. THE INDUSTRY CONSUMES 10 TONS OF BEESWAX FOR LUBRICATING BOLTS, 2,500 TONS OF TURPENTINE FOR PAINTS, AND LARGE QUANTITIES OF WOOL, COTTON, WOOD AND PRODUCTS MADE FROM CORN, WHEAT, ETC.

Industrial Notes

Paper towels that have the characteristics of cloth have been placed on the market under the name of Soft-Tuff. They are made by the Scott Paper Company and are said to be soft, pliant, and highly absorbent.

Absentminded motorists, who not infrequently forget to release the brake when they start, may be interested in a gadget that sounds an alarm when both the brake and the ignition are on. It might save them money.

Diesel-engined trucks are advocated for tunnel work because their exhaust is virtually free of carbon-monoxide gas. Ten of them are being used on the New York Midtown Tunnel for hauling heavy loads up a steep grade to the street level.

In the airplane factory of the Glenn L. Martin Company, a total of $12,500 is saved annually by passing floor sweepings through a series of ingenious mechanical sifters and devices that salvage such small items as rivets, bolts, nuts, etc., and sort them according to diameter, length, and shape of head.

Flexible extensions for flashlights add considerably to the latters' usefulness. The Sierra Aircraft Company is offering them in lengths ranging from 6 to 36 inches, complete with screw plug and light socket. They are made of a high-grade aluminum-alloy tubing carrying special copper wire, and can be bent indefinitely it is said into any desired shape to reach otherwise inaccessible places, or to stand or hang up so as to leave both hands free to work. The extensions can be inserted into openings as small as 7/16 inch in diameter.

Grease cups on machines are often necessarily located where they are not readily visible and, as a result, some may be overlooked while they are being gone over and filled. A cup that is not taken care of can cause trouble, its position then being announced by the appearance of smoke and the stench of burning grease. A simple and

novel method of making sure that no cup is missed is by marking their caps, as shown in the accompanying illustration. The number of cups to be attended to on the machine of which this one is a part is indicated by the lower and smaller numeral, while the upper and larger one shows that this particular cup is No. 3, or the third of a total of seven on a blower. With this system, even one who is not familiar with the machine knows immediately how many cups there are and can fill them in rotation, or otherwise. In any event, he can be certain when he is through that all of them have been attended to.

A new 36-page illustrated bulletin describing the Eimco-Finlay loader, Models 12-B and 21, has been issued by the Eimco Corporation, Salt Lake City, Utah. In addition to explaining the construction and operating characteristics of the loader, the publication shows how it can be applied to different systems of mining. Free copies of the bulletin, No. 105, are available to prospective users of this type of equipment.

According to U. S. Commerce Reports, a well-known Swedish automobile expert has discovered that crude turpentine can be used as a motor fuel simply by interposing a copper plate between the cylinder and the motor block. There is a hole in the plate smaller than the cylinder opening, and this, together with the heat of the copper gasket, serves to atomize the turpentine. So far it has been tried only in connection with Hanomag automobiles, or cars having top intake valves.

Stalinets are Russian freight locomotives of a new type that can be run by a diesel engine or a steam engine or both, according to the inventor, L. M. Maizel. The steam engine burns coal dust, which is also converted into gas to serve as fuel for the diesel. The gas producer is carried on the tender, together with a coal pulverizer and a condenser. The unit is said to make 53 miles an hour and to use far less coal than the ordinary steam locomotive.

Substations on wheels, complete with switching and protective equipment, are being built by the General Electric Company for the use of power companies. They are a quick means of supplying current at any point along a distribution circuit in case of emergency, or where temporary loads demand increased service. There are two general types: one with a self-cooled transformer suitable for continuous use over extended periods, and the other with a forced-cooled transformer. The latter is a high-capacity unit and is well adapted for emergency service.

Misunderstandings and mistakes in important business transactions by telephone can be prevented by the use of an instrument that permanently records both ends of the call. It is interposed in the line and plugged into any convenient alternating-current outlet. The conversation is recorded on ordinary phonograph disks and

played back by throwing a switch. A 4-tube amplifier serves to operate the cutter as well as the speaker, and means are provided by which the volume of the tone can be regulated. The unit measures 10x15 inches and uses disks 0.025 inch thick that take up little room and are easily obtainable. It is being marketed by the Mellaphone Corporation.

What is described as a fist-grip clip for wire rope is being manufactured by Thomas Laughlin Company. Its main advantage, as compared to the ordinary U-bolt clip, is that it equalizes the pressure on the rope because it has bolts and identical bearing surfaces that conform to the contours of the rope on both sides instead of a single, flat bearing-surface saddle and bolts on one side. The claims made for the Laughlin Safety Clip are: Ease of application; less rope crushing, distortion, and breakage; and a 20 to 30 per cent increase in holding power.

Concrete can be "case-hardened," it is claimed, to a depth of 1½ inches by lining the forms with a new absorptive material. The latter removes much of the trapped

air and excess water in the mass immediately in contact with it and thus gives the concrete added density and strength where it is needed to resist abrasion, chemical attack, and weathering.

Steam flowing through a pipe can be superheated by a new finned electric element that is introduced in the line and intersects the flow. The unit comes in different lengths, is rustproof, and has a maximum electrical rating of 3,700 watts.

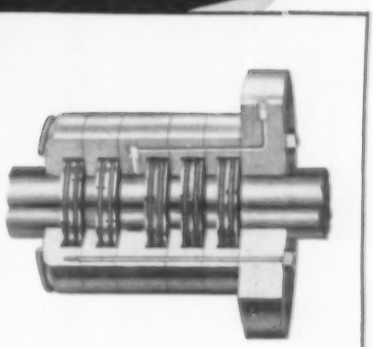
In several paper mills in Canada, the warm, moist air in the hoods of papermaking machines is made to give an account of itself by leading it to towers where it gives up its heat to cascading water. There are many uses for warm water around such plants, including that of de-icing logs.

Ladders that can be ascended from either side, or used by two persons, are being offered by the Aluminum Ladder Company. They have steps on both sides and a sizable platform; are built of a special aluminum alloy for lightness and strength; and come in two sizes—one 3 and the other 4 feet high.

Catalogue No. 207 recently published by the Goodall Rubber Company, Inc., Philadelphia, Pa., describes its general line of mechanical rubber, including 74 items heretofore not listed. Of the 68 pages of text and illustrations, 56 are given over to hose and belting, not including technical data on those and allied subjects. The book is well and attractively bound and should prove helpful to mines and quarries, utilities, municipalities, and construction, petroleum, chemical, and other industries in which rubber products play an indispensable part.

Rods of Lucite, a methyl methacrylate plastic introduced by E. I. du Pont de Nemours & Company, can "pipe" light or reflect it from one point inside of it to another and provide heatless illumination. Because of this property the material has been fashioned into surgical instruments that make it possible to throw light on body cavities that cannot be reached by flashlights or other more conventional apparatus. Small, standard-type flash batteries held in a metal base in the handle of the instrument are the source of light, which issues from the rod only where the outer surface has been embossed. Otherwise it has the smoothness of a ground lens and the appearance of the finest crystal. The tubes can be used with safety because they are nonshatterable; and they are curved to facilitate getting into inaccessible nooks and corners. According to a recent announcement, Lucite flashlights for industrial use are now available and come in sets of three interchangeable rods of different shapes.

NOW non-scuff, double-quick seating
COOK'S PACKING RINGS
. . . they're TINIZED*



. . . which further reduces friction and prolongs rod and packing life . . .

* Patent applied for

THIS latest COOK development makes available for extreme service conditions, COOK'S Metallic Rod Packings fitted with COOK'S Graphitic Iron Packing Rings having **pre-conditioned** wearing surfaces.

This is the same "Tinized" surface treatment that has proved so successful on COOK'S Graphitic Iron Piston Rings. By a special electrical process the entire wearing surfaces of the packing rings are covered with a coating of a tin-base, anti-friction metal.

The benefits of these pre-conditioned wearing surfaces will be at once apparent to both designing and operating engineers—how they protect the rod from scuffing and undue wear during the break-in period—how they promote quicker "mating" of ring and rod surfaces—how they still further decrease friction and extend the life of both rod and packing to new limits.

COOK'S TINIZED Metallic Rod Packings offer you the utmost in packing performance and economy. Specify them next time you order equipment. For equipment in service, order from the equipment maker or direct from us.

COOK'S METALLIC ROD PACKINGS are made in types for every engine and compressor rod service. In addition to the Graphitic Iron Packings the line includes COOKMET, Hard Babbitt and Laminated Bakelite Packings. We'll be glad to make packing recommendations for your particular requirements. Write us.

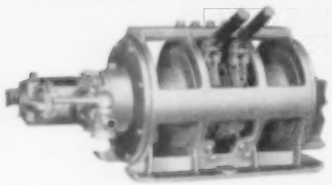
SEALING PRESSURES

SINCE 1888

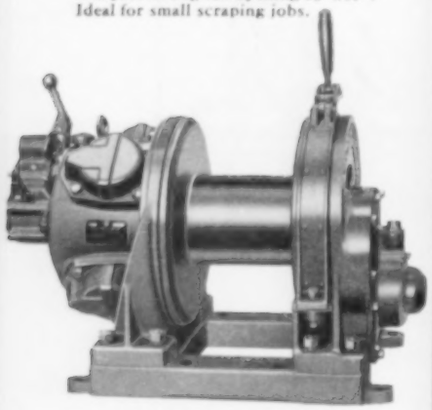
C. LEE COOK MANUFACTURING CO.
INCORPORATED
New York Cleveland Los Angeles Baltimore LOUISVILLE, KY. Chicago Tulsa New Orleans San Francisco

"UTILITY" AIR HOISTS

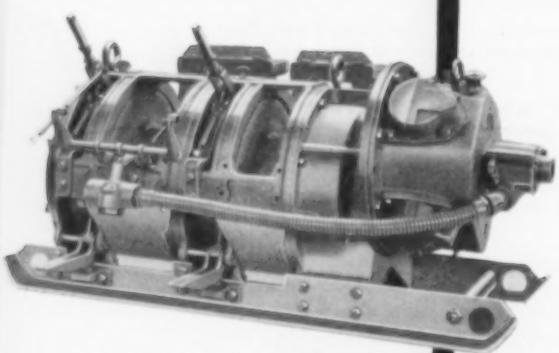
LEAD THE FIELD WHERE THE GOING IS TOUGH!



Size A4NN-OJ Double-Drum "Utility" Air Hoist. Weighs only 250 lbs. and will pass through an opening 13"x15". Ideal for small scraping jobs.



Size K4U Single-Drum "Utility" Air Hoist.



Size KNM-2G "Unit-Assembly", Double Drum "Utility" Air Hoist

32 Sizes and Types of Air Hoists

SINGLE AND DOUBLE DRUM

Sturdy Design • Economical to Operate • Avoid Costly Interruptions

for **Scraping in drifts and stopes Hoisting, skidding timbers • Handling fill Moving cars • Handling obnoxious materials • Leveling stock piles Scraping ore into bins.**

The "Utility" Air Hoist is a typical underground "work horse", always doing its job, no matter how tough, and seldom needing attention, except for an occasional greasing. You will find these dependable units in use in mines everywhere, because they speed up work and reduce costs.

Many of the double-drum sizes are on scraping service in drifts and stopes.

The single-drum units are spotted everywhere—pulling material up raises, handling fill, moving cars, skidding timbers, etc. Whatever the job is, it is being done well and without interruptions or breakdowns.

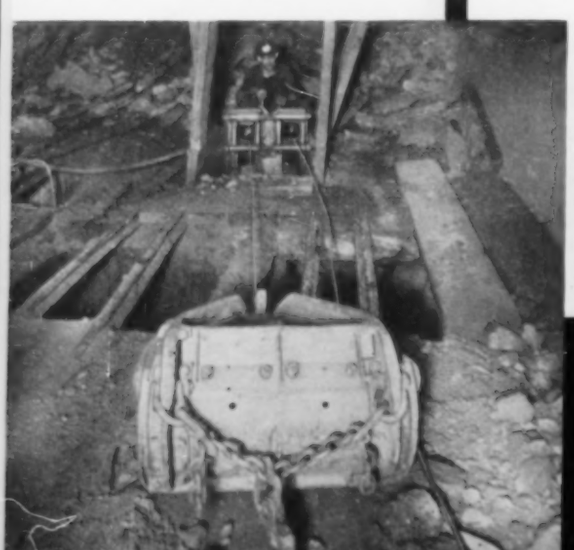
Consider the "Utility" the next time you have a scraping or hoisting problem to solve. You can always depend upon them.

420 Sizes and Types of Electric Hoists are Available

Ingersoll-Rand

11 BROADWAY, NEW YORK

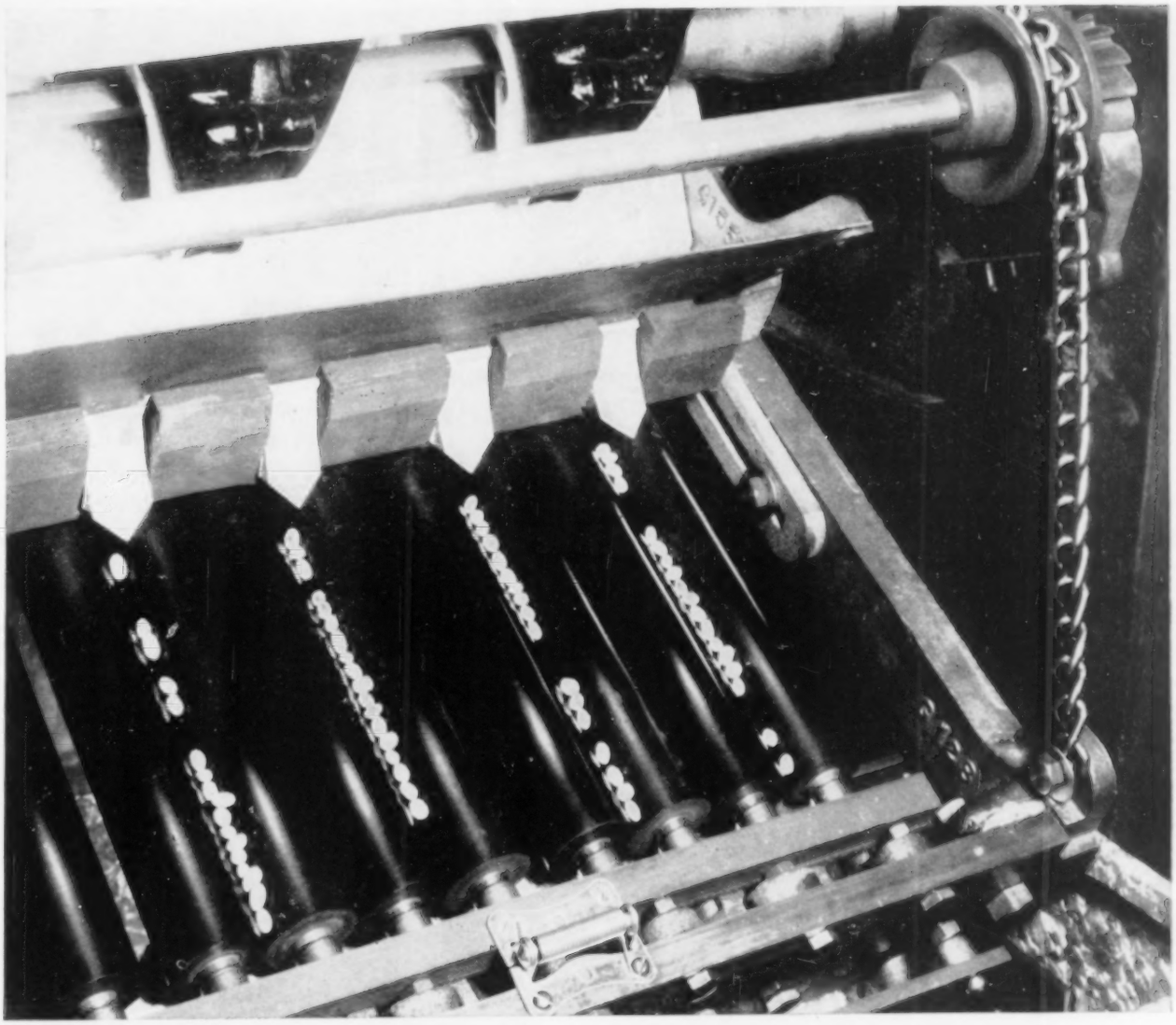
928-B



A Size HNN-1J Double-Drum "Utility" Air Hoist pulling a 36-inch scraper.

A Size K4U "Utility" Air Hoist hauling a loaded trip in a mine.

A Size A4NN-OJ Double Drum "Utility" Air Hoist operating a 26-inch scraper in a square set stope.



The machine that censors the bean crop

A typical example of Goodrich development in rubber

As THEY come from the field, beans for "Boston baked" are bound to include a certain number of hard, wizened "culls." If these had to be picked out by hand, bean prices would be a lot higher. But beans are still a great American staple—because of rubber.

A manufacturer invented a machine that would spread beans over whirling pairs of rubber rolls. The beans move down along the rolls, and the inferior beans which are small and wrinkled were supposed to be caught between the rolls and be carried down to a waste bin.

But it didn't work. The rolls were too hard—they crushed good beans, and failed to catch many of the culls.

The manufacturer had heard of the unusual things Goodrich has done with rubber, so he came here. Goodrich engineers had had years of experience with rolls in paper and steel mills. They developed a rubber with a special finish—polished so that the good beans which are smooth slip over it, but just soft enough to seize any bean that is wrinkled, and pull it down and away. Thousands of these Goodrich rolls are in use today, working efficiently, lasting for years.

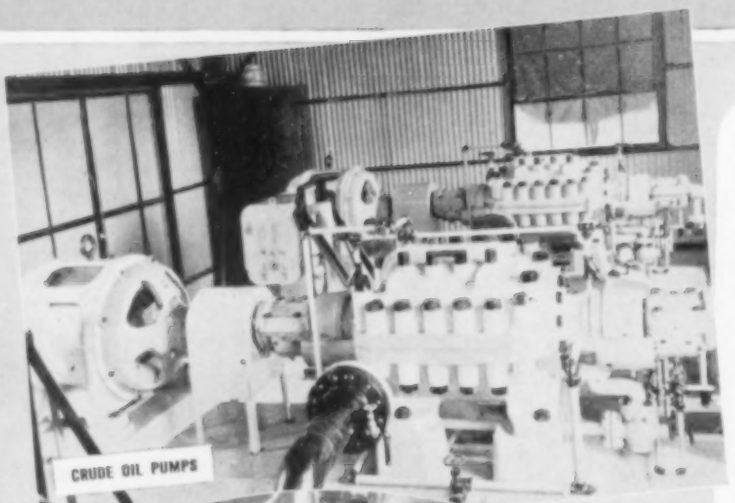
Probably the next baked beans you enjoy will be better because of this Goodrich development—and if they're canned, the can will probably be sealed with Goodrich cement, after being cleaned with Goodrich steam hose, its label made by Goodrich printing plates, and carried throughout the cannery on Goodrich conveyor belt.

(A booklet of reprints of recent Goodrich advertisements in this series will be mailed free on request. Just write to *Department C10, The B. F. Goodrich Company, Akron, Ohio.*)

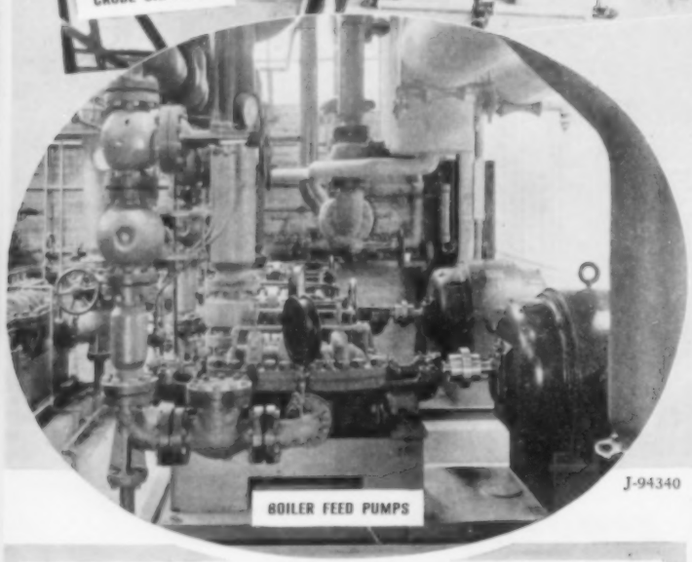
Goodrich

ALL *product problems* IN RUBBER

WESTINGHOUSE DRIVES FOR INGERSOLL-RAND PUMPS



CRUDE OIL PUMPS



BOILER FEED PUMPS

J-94340

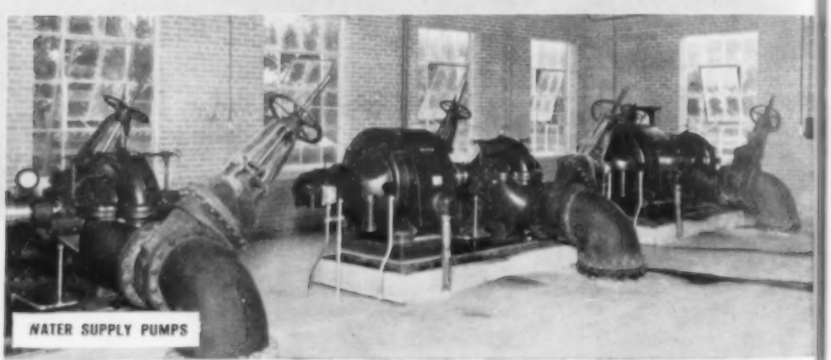
Matched performance is one of the outstanding advantages of a Westinghouse driven Ingersoll-Rand pump installation. That's because Westinghouse drives are carefully co-ordinated with the pumping apparatus as a whole to do a specific job.

Westinghouse experience and close co-operation with plant owners, engineers and contractors, and pump manufacturers are responsible for the complete satisfaction delivered by Westinghouse drives, regardless of the type of service.

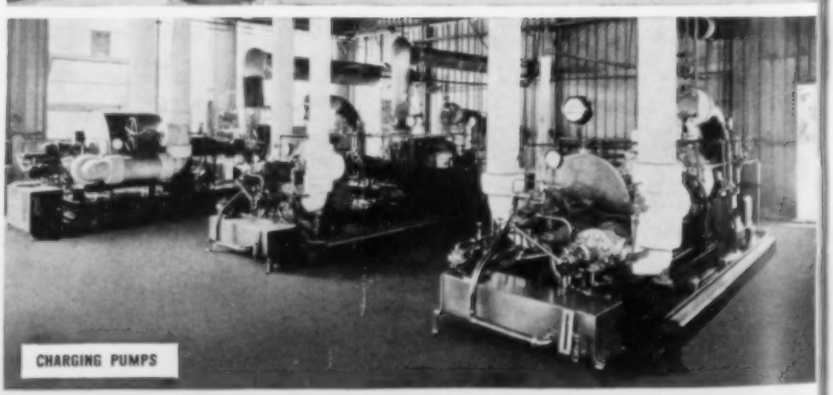
This "working partnership" is quickly available through your local Westinghouse office.

WESTINGHOUSE ELECTRIC & MFG. CO.
EAST PITTSBURGH, PA.

Tune in "Musical Americana," N. B. C. Blue Network, every Thursday evening



WATER SUPPLY PUMPS



CHARGING PUMPS

PUT THIS EXPERIENCE TO WORK FOR YOU

For 50 years, Westinghouse has worked side by side with Industry to provide drives that stand up in service and are properly co-ordinated with mechanical equipment. Westinghouse engineers are thoroughly familiar with pumping problems—and they are ready to co-operate with you on any job. You can obtain their assistance through your local Westinghouse office.

Westinghouse

ELECTRICAL PARTNER OF INDUSTRY

W WESTINGHOUSE ELECTRIC

QUESTION

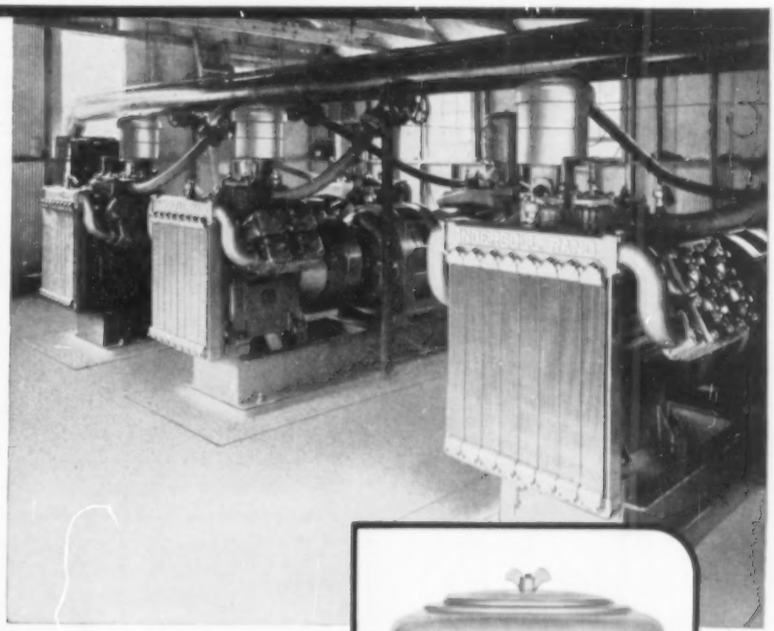
HOW CAN WE PROVIDE OUR EQUIPMENT WITH DEPENDABLE PROTECTION AGAINST DUST AND GRIT AND AT THE SAME TIME AVOID OBJECTIONABLE INTAKE NOISE?

ANSWER

INSTALL

Air-Maze

OIL BATH FILTER-SILENCERS



• Air-Maze Filter-Silencers solve the two-way problem of combining *dependable* air filter protection with effective intake silencing.

This noteworthy development is more than a silencing device "added on" to a filter. Air-Maze engineers have developed a highly efficient Acoustical Chamber as an *integral part* of the famous Air-Maze air filter. The new Air-Maze Filter-Silencer provides the same 99.83% protection against dust and grit. Simultaneously, it effectively eliminates objectionable intake noise.

Air-Maze offers two types of Filter-Silencer units; each of which is available in a variety of sizes: the *Oil Bath* type (shown at right) with automatic oil-washing action and the *Unimaze* type, with a viscous coated filter element. Both types are characterized by extremely low pressure drop, easy installation and simple servicing features. Full details given in AIR-MAZE bulletin FSP-89. Write for it today.

AIR-MAZE FILTER SILENCER

Oil Bath Type, Model 8-N Observe Acoustical Chamber which is lower part of assembly

AIR-MAZE CORPORATION

5206 HARVARD AVENUE CLEVELAND, OHIO

AIR-MAZE

DEPENDABLE AIR FILTERS FOR EVERY APPLICATION

COMPRESSOR EQUIPMENT

SOUNDLY DESIGNED • STURDILY CONSTRUCTED

ERIE GOVERNORS— For steam engines, pumps or compressors. For speed control only or for combined speed and pressure control.

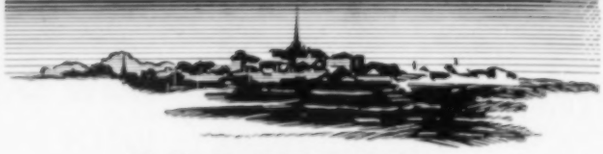
ERIE UNLOADER—Maintains constant pressure by governing inlet of compressor. Loads and unloads without shock or strain.

JARECKI VALVES—Sizes and types to meet every condition, each soundly built, perfectly threaded and individually tested.

JARECKI FITTINGS—Air-furnace malleable fittings...close-grained, cast iron fittings, all with perfect threads. A complete line.

JARECKI MANUFACTURING COMPANY
ERIE, PA., U.S.A.

MIDNIGHT SILENCE



by MAXIM

In La Junta, Colorado

Maxim MU2 Silencers provide real and necessary silencing for the La Junta Light & Power Plant, operating 24 hours a day within the town itself, 36 feet from the nearest private residence and close to a hotel.

Showing Maxim MU2 Silencers on La Junta Light & Power Plant.

There's not much noise in La Junta at night, and this community would quickly notice any deviation from the perfect silencing afforded by these MU2 Maxim Exhaust Silencers.

Write for details

THE MAXIM SILENCER CO.

85 HOMESTEAD AVE. HARTFORD, CONN.

Is Your P.A. the "Forgotten Man"?

MEET the S. M., the G. M. and the Designing Engineer. They are all enthused about a new Company product. They've been sitting up nights to perfect it and now it *must* succeed.

But hold! Where is the Purchasing Agent? He should be in on this. Think of the long preparation and expense—the Company reputation at stake—the make or break of future business.

Call in the P. A.! Explain your plans for Quality and he will do the rest. He knows there is safety, and economy, in Atlas Micro-proven Drop Forgings.

No Guesswork at Atlas. Complete Laboratory Control and Recorded Heat Readings.

THREE PLANTS IN ONE

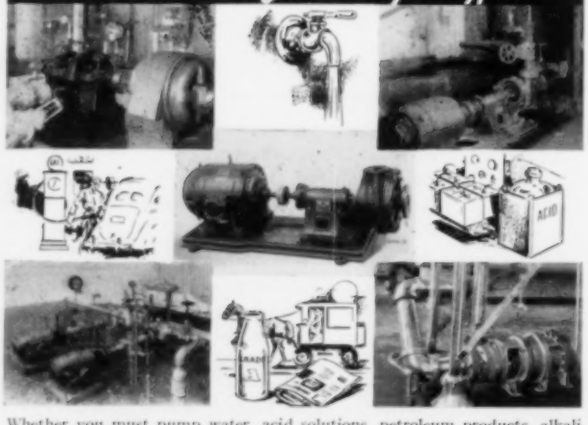
ATLAS DROP FORGINGS

All shapes and sizes to 500 lbs.

ANY ALLOY STEEL • LABORATORY CONTROLLED

ATLAS DROP FORGE CO., LANSING, MICH.

PUMPS—*for any liquid*



Whether you must pump water, acid solutions, petroleum products, alkali solutions, there is an Ingersoll-Rand pump to fill your needs in an economical and dependable manner.

Ingersoll-Rand engineers and metallurgists have had wide experience in building pumps for handling all types of liquids.

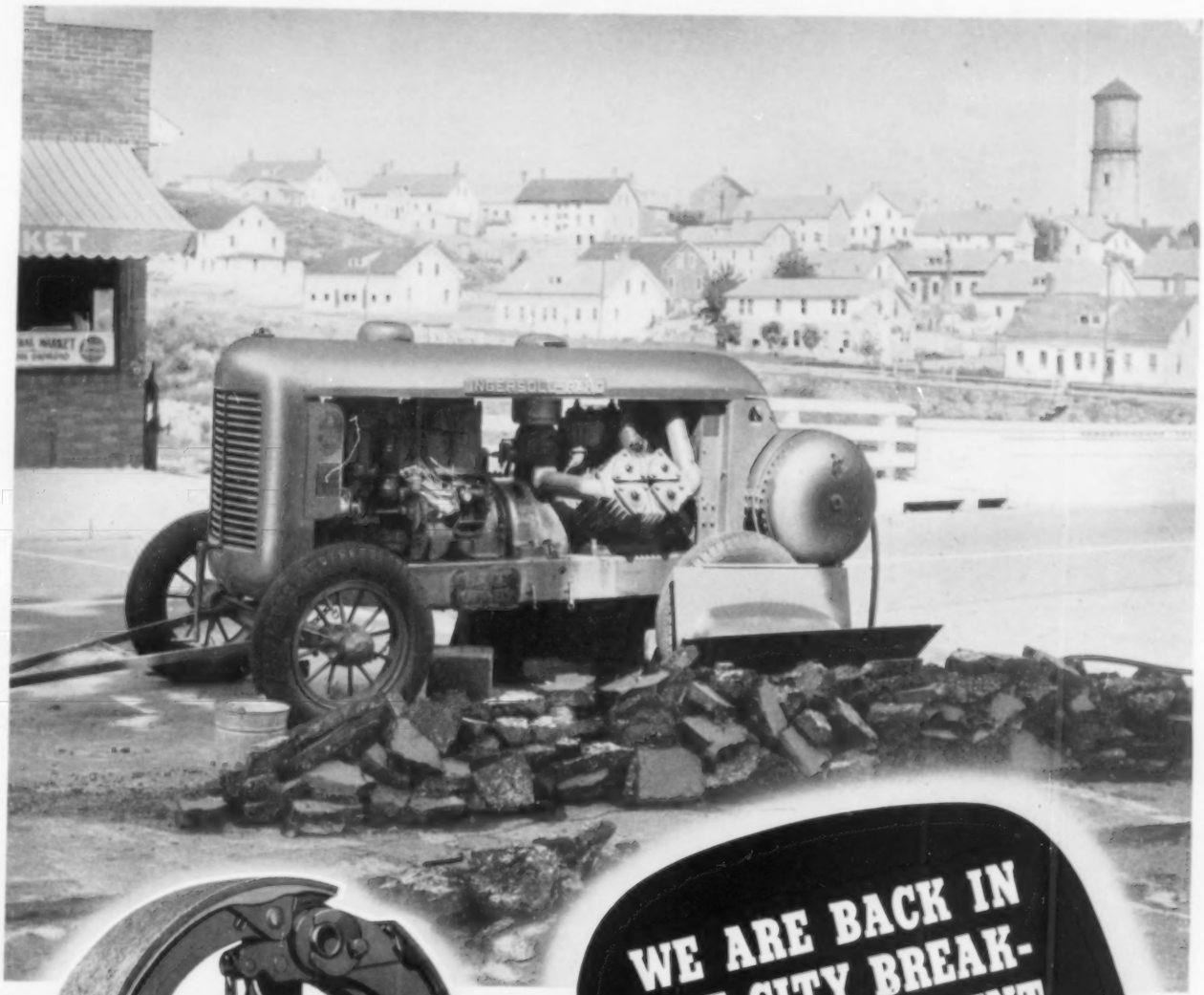
Ask our engineers about the pumps listed below—one of them may help you reduce your liquid handling costs.

PUMP	PRESSURE RANGE	CAPACITY RANGE
The Motorpump Class TRV, turbine driven pump Class CRV, cradle mounted pump	5 to 225 lbs.	5 to 1500 gpm.
Single-stage, Coupled-Pumps in sizes from 1½ to 24 in.	10 to 130 lbs.	25 to 30,000 gpm.
Class GT, 2-stage pumps	100 to 425 lbs.	100 to 2200 gpm.
Class NT, 4- and 6-stage pumps	100 to 600 lbs.	50 to 600 gpm.

Ingersoll-Rand

Cameron Pump Division

11 BROADWAY, NEW YORK, N. Y.



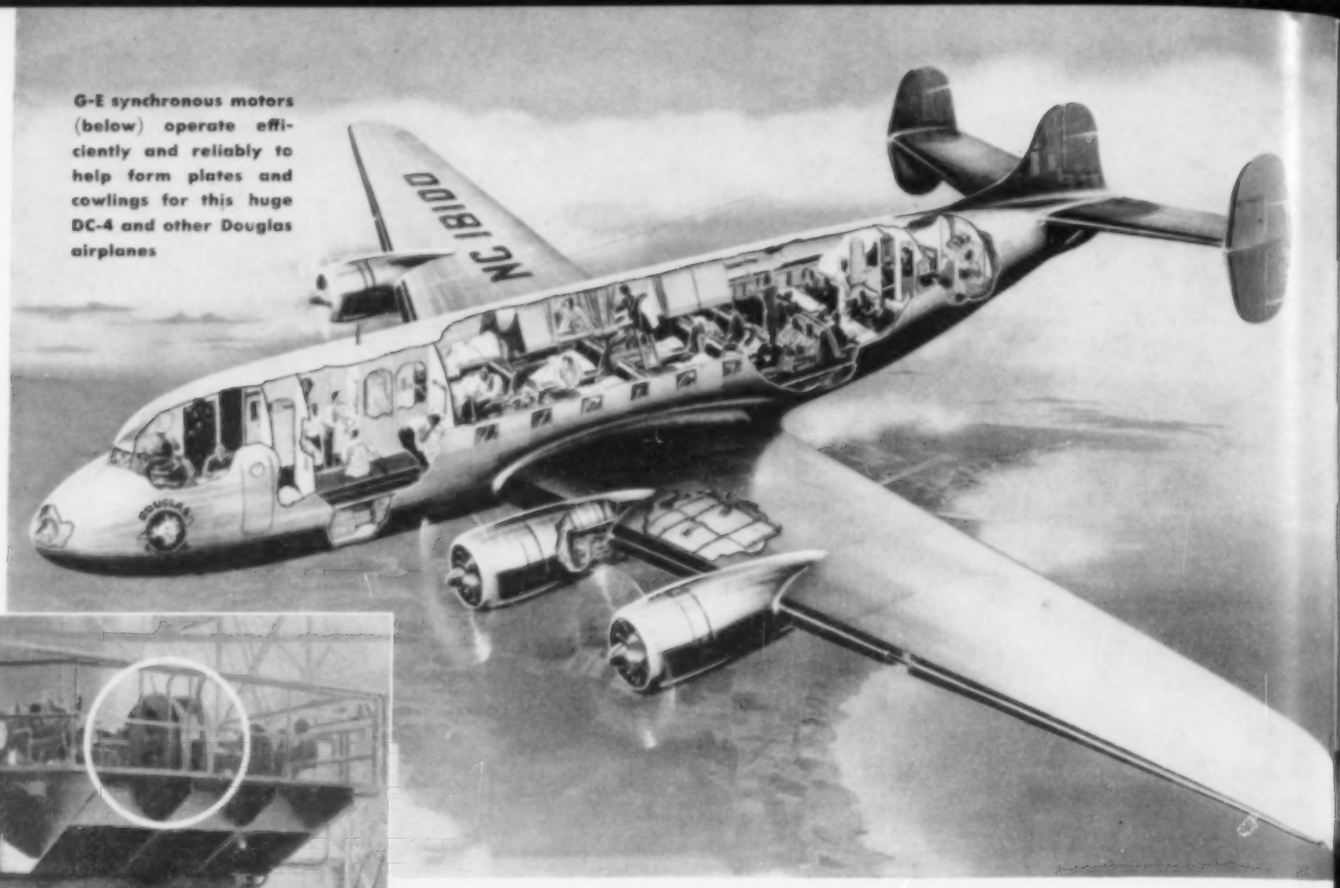
The Fawick Shoe Clutch transmits power from engine to compressor with the very minimum of adjustment and maintenance, making it ideal for portable compressors where changing operators may overlook or omit checking up the equipment.

WE ARE BACK IN THE CITY BREAKING UP PAVEMENT

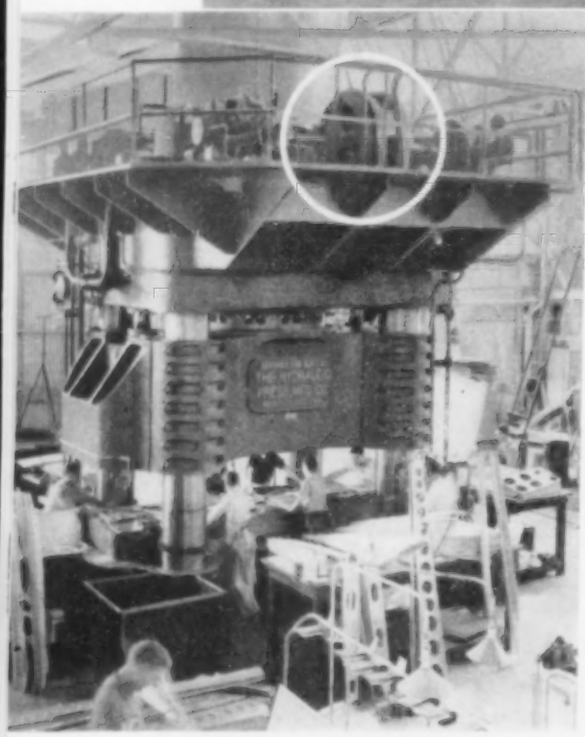
It was more fun perhaps following us and the I-R Portable Compressor along the Pennsylvania Turnpike, through the Kentucky Hills, and around Grand Coulee Dam. This job where you catch up with us again is a prosaic one in a Rhode Island town calling only for speed, efficiency, and dependability of equipment to get at a sewer main. For keeping the air on uninterruptedly the Fawick Clutch with the I-R Portable Compressor make a great team.

INDUSTRIAL CLUTCH COMPANY

Waukesha Wisconsin



G-E synchronous motors (below) operate efficiently and reliably to help form plates and cowlings for this huge DC-4 and other Douglas airplanes

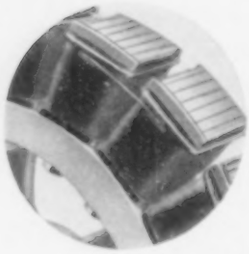


How TWO G-E SYNCHRONOUS MOTORS Helped Build This Hotel-on-Wings

IN ONE of the world's largest aircraft plants—that of the Douglas Aircraft Company of Santa Monica, California—two G-E synchronous motors drive pumps for operating the giant hydraulic press that fabricates plates, cowlings, and other parts for all Douglas airplanes, including this huge DC-4. The two motors have been in operation for more than two years and have proved themselves to be reliable and efficient pump drives. In addition, the Douglas Company has earned approximately $1000 a year in bonuses due to the power-factor improvement made possible by these two motors.

Synchronous motors are the most efficient and reliable drives for many constant-speed applications, such as certain types of compressors and pumps. Their inherent ability to improve power-factor means lower energy charges, lower demand charges, and often, lower power rates. In addition, they assure better operation of all other electric equipment because of improved voltage regulation. The efficiency of the entire distribution system is increased because line losses are minimized.

Why not investigate the possibility of making savings in your own plant through the use of synchronous motors? G-E application engineers will be glad to help you. Call the nearest G-E office, or write General Electric, Schenectady, N. Y.



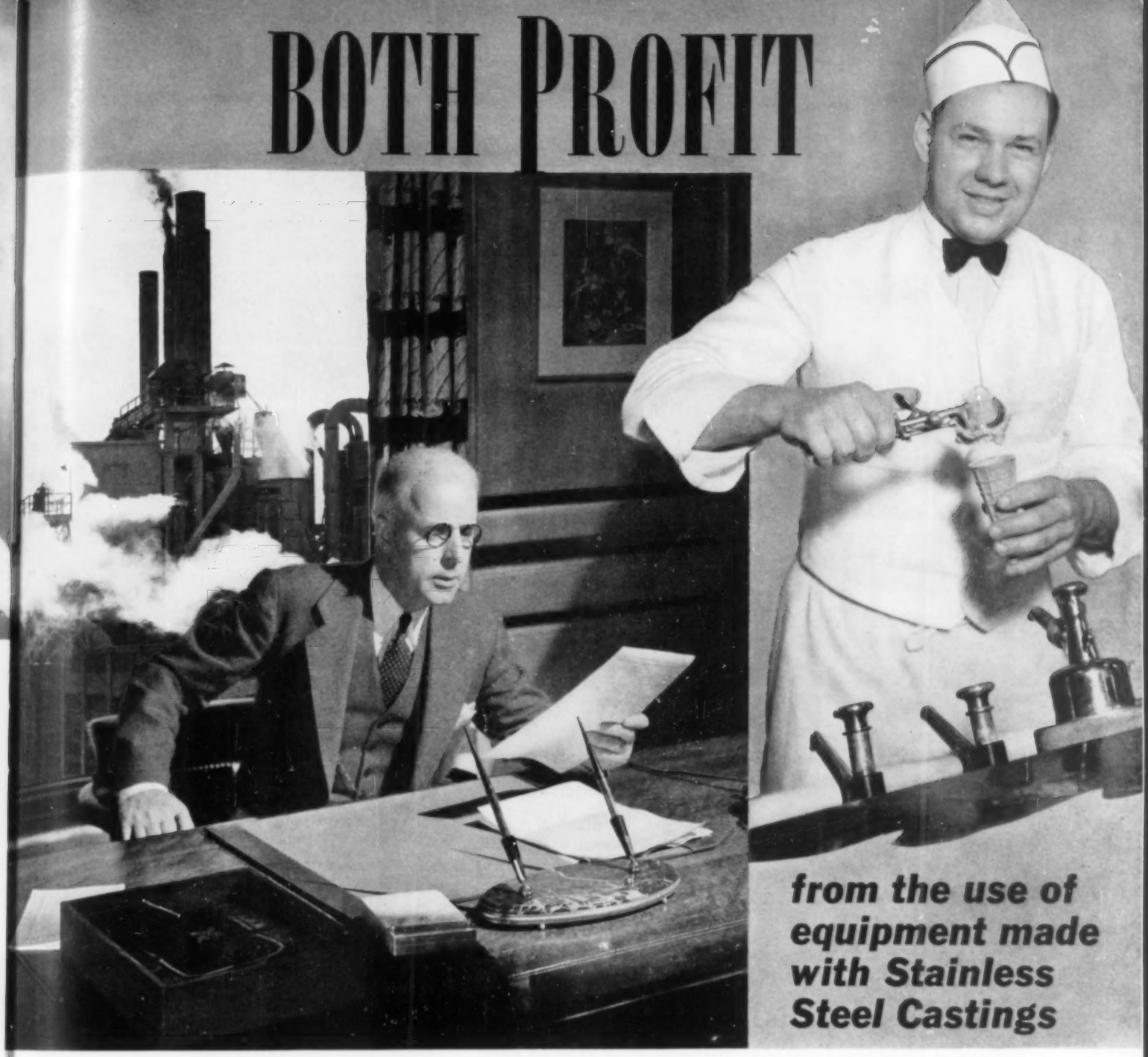
In G-E synchronous motors the bars of the amortisseur winding are fitted into holes in the heavy, sectionalized, copper end-rings and are silver-soldered at red heat to form low-resistance, brazed alloy joints of high mechanical strength. This arrangement permits easy removal of one or more field poles without disturbing the remaining poles

Low core loss is assured by laminations of best-grade, nonaging, silicon sheet steel, carefully annealed and enameled. Deep, radial I-bars, spot-welded to the outside laminations, assure a uniformly tight core and quiet operation

GENERAL ELECTRIC

040-54

BOTH PROFIT



from the use of equipment made with Stainless Steel Castings

CIRCLE L

STAINLESS ALLOYS

Lebanon's CircleL Corrosion-Resistant Alloys cover a wide range both in analysis and properties. Bulletins describing these alloys will be sent upon request.

LEBANON STEEL FOUNDRY
LEBANON, PENNA.

ORIGINAL AMERICAN LICENSEE
GEORGE FISCHER (SWISS CHAMOTTE) METHOD

INDUSTRIALIST who oversees the working of a multi-million dollar plant—proprietor of the corner confectionery—both may profit from the use of stainless steels in their equipment. Alert manufacturers are meeting the demand from their customers, large and small, for corrosion-resistant materials.

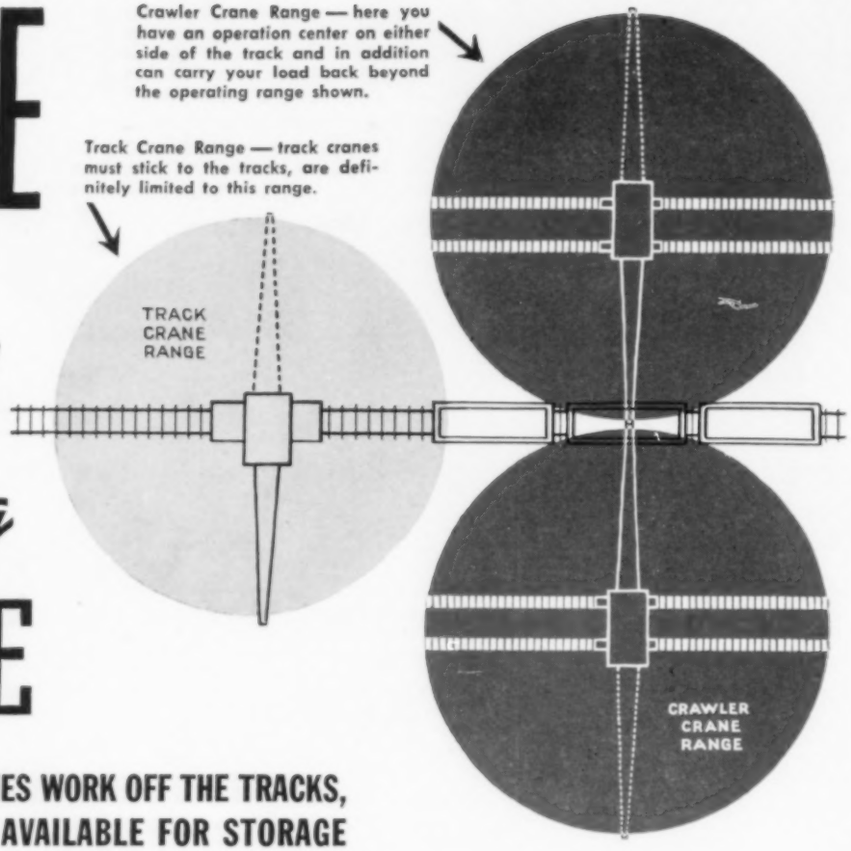
Many equipment makers have come to Lebanon for help in selecting the proper alloy for their particular purpose. Machining, welding and response to heat-treatment—these and other important factors influence the practical use of the new corrosion-resistant alloys.

Because we approach these matters realistically—because of our long experience with these alloys and their application to scores of industries, more and more makers and users of equipment which is subject to corrosive action "put it up to Lebanon".

Perhaps you, too, can profit by "putting it up to Lebanon".

Lebanon STAINLESS AND SPECIAL ALLOY Steel Castings

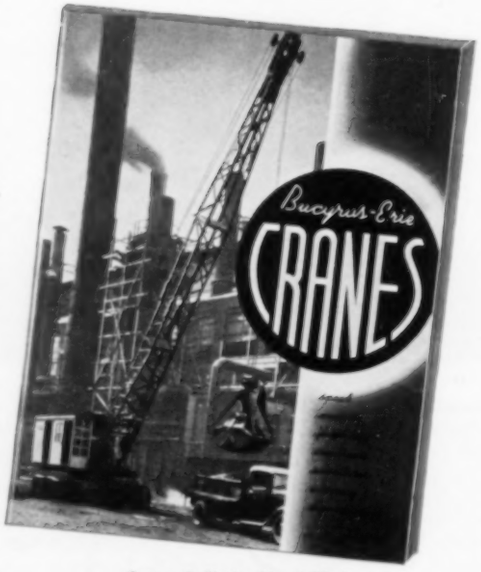
DOUBLE *your Material Handling* RANGE


Crawler Crane Range — here you have an operation center on either side of the track and in addition can carry your load back beyond the operating range shown.
Track Crane Range — track cranes must stick to the tracks, are definitely limited to this range.
TRACK CRANE RANGE
CRAWLER CRANE RANGE

BUCYRUS-ERIE CRAWLER CRANES WORK OFF THE TRACKS, MAKE EVERY FOOT OF YARD AVAILABLE FOR STORAGE

Working alongside the track on the radius of its swing circle, a Bucyrus-Erie crane can reach into a car and swing 180° to pick up or place its load just twice as far out as a track crane of equal boom length. Result: you double the storage space available at a single handling. You also eliminate switching delays and train crew expense — Bucyrus-Erie crawler cranes can work a whole train of cars as they are moved past the crane, or can move along the track, working each car in turn. Nor need you be limited to the space immediately adjacent to the tracks or underneath overhead cranes. Bucyrus-Erie cranes pick up stock, carry and place it wherever you want it — every foot of yard is made available for storage space.

To expand your storage space . . . gain time . . . and save money, investigate the Bucyrus-Erie crawler crane method of material handling. Crane bulletin No. LCC-1 gives you the whole story. Write for it NOW.



Crane Bulletin No. LCC-1 . . . yours for the asking.

Bucyrus·Erie

SOUTH MILWAUKEE, WISCONSIN

TUNNELING IS A HERCULES JOB

—whether it is a metal-mining drainage tunnel, a water-supply tunnel, a tunnel for railroad or highway, a hydroelectric or other construction project, you'll find Hercules Gelamite* on the job... Its plasticity, cohesiveness, fumes, water resistance, economy, and results make record-breaking yardages possible.

That's why it's the standard explosive for tunneling.

*Reg. U. S. Pat. Off., by Hercules Powder Company

E-21

EXPLOSIVES DEPARTMENT

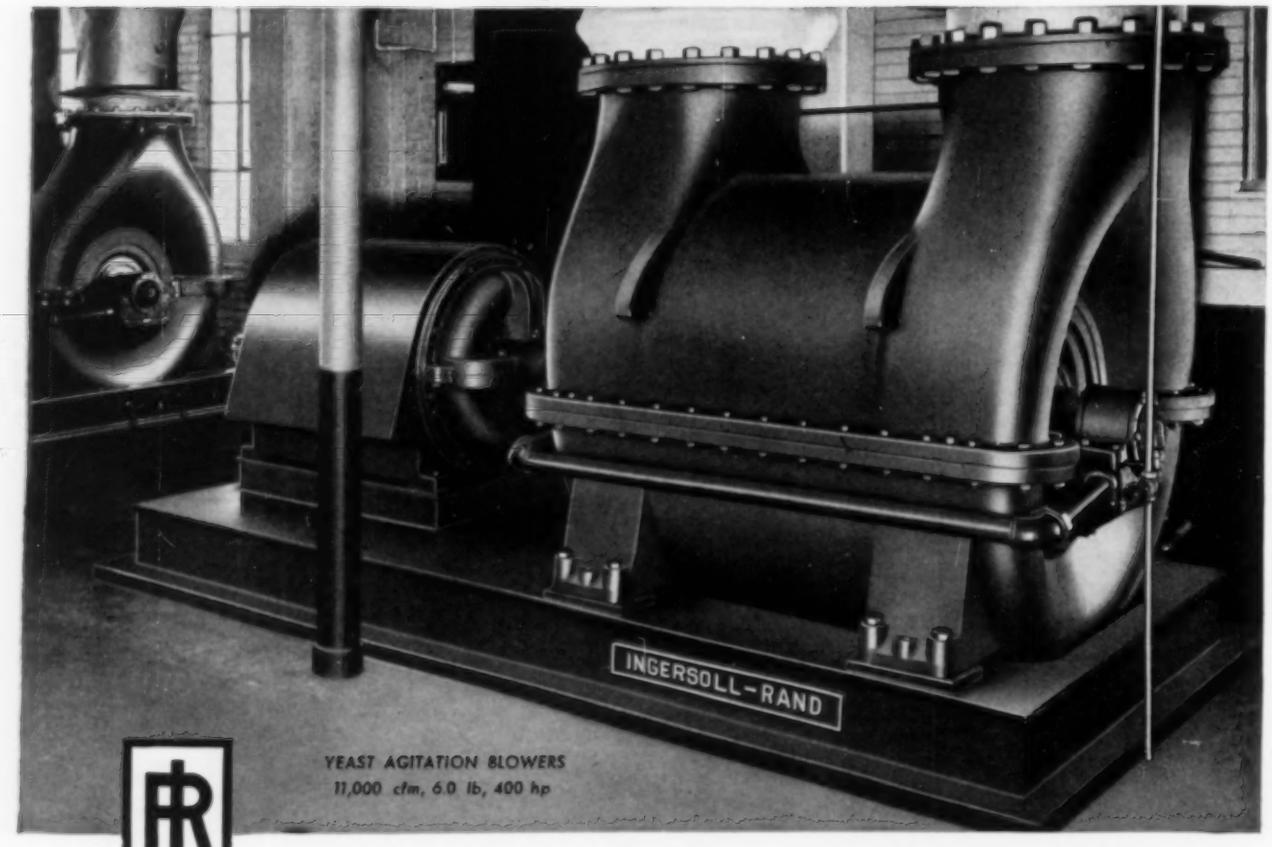
HERCULES POWDER COMPANY

Incorporated

WILMINGTON • DELAWARE

✓ CLEAN OIL-FREE AIR
✓ LOW POWER COST
✓ DEPENDABLE SERVICE

Use I-R Agitation Blowers



YEAST AGITATION BLOWERS
11,000 cfm, 6.0 lb, 400 hp

- I-R turbo blowers are widely used for agitation and aeration processes, because they deliver clean oil-free air, and supply that air at the lowest possible cost for power and maintenance.

Many field applications plus 25 years of continuous research have resulted in the present compact and simple construction of I-R turbo blowers.

A representative of the nearest Ingersoll-Rand branch will be pleased to work with you in the solution of your problems. Back of him is a specialized engineering staff and unequalled blower building and testing facilities.

Other I-R Products: Compressors, Pumps, Condensers, Blowers, Vacuum Pumps, Diesels, Ref. Units, Rock Drills, Pneumatic Tools

Atlanta
Birmingham
Boston
Buffalo
Butte
Chicago
Cincinnati
Cleveland
Dallas
Denver
Detroit
Duluth
El Paso
Hartford
Houston
Kansas City

Ingersoll-Rand

11 BROADWAY, NEW YORK CITY

B70-12

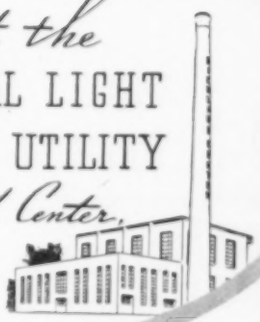
Knoxville
Los Angeles
Newark
New Orleans
New York
Philadelphia
Picher
Pittsburgh
Pottsville
Salt Lake City
San Francisco
Scranton
Seattle
St. Louis
St. Paul
Tulsa
Washington

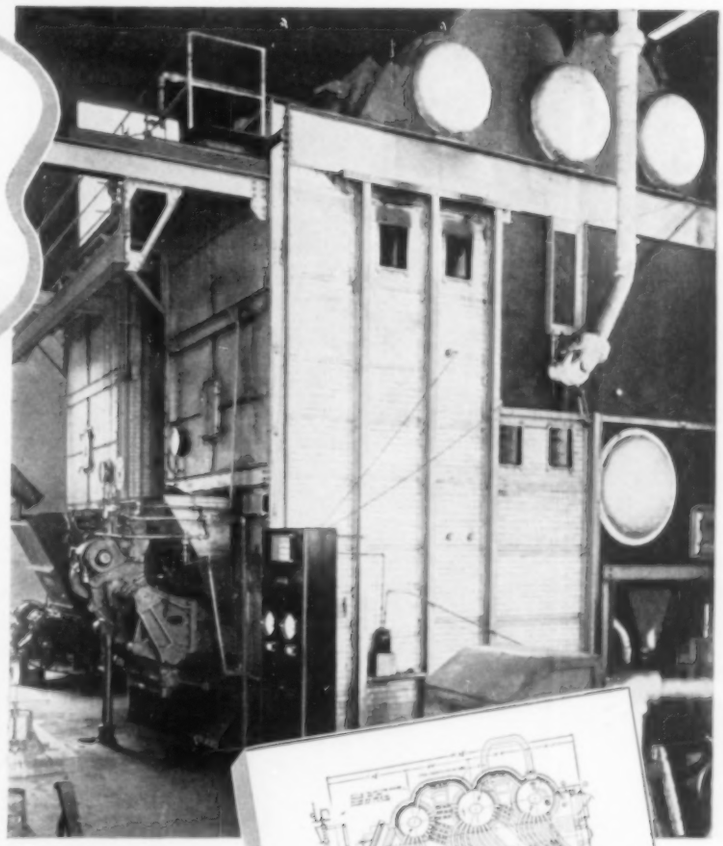
Two Vogt Boilers

BURN 230 TONS *LESS* COAL

AND *INCREASE* POWER 88%

at the
MUNICIPAL LIGHT
AND WATER UTILITY
Richland Center,
Wisconsin





THIS modernly equipped plant, served by two Vogt, four-drum, bent tube boilers, provides dependable, low-cost service the year around for the city of Richland Center, Wisconsin.

A comparison was recently made of the 1939 power output with that of 1935, when boilers of another type, now replaced by the Vogt units, were in service. Plant records revealed that in 1939 a total of 230 tons LESS coal were burned while 2,188,160 MORE K.W. hours were generated than in 1935; a *decrease* in coal consumption and a power *increase* of 88 per cent!

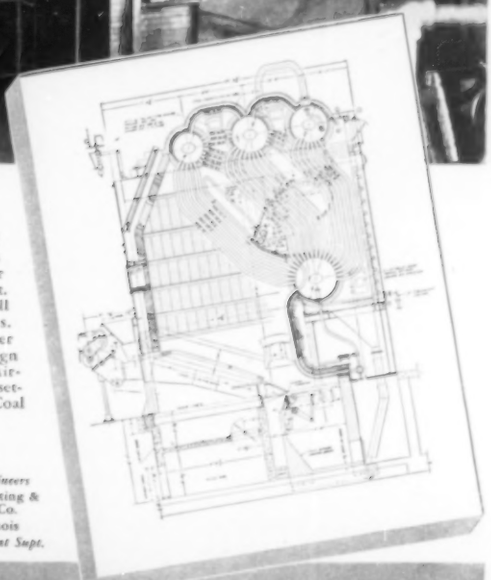
Economize through modernization—Consult Vogt engineers on your steam generating problem!

HENRY VOGT MACHINE CO.
Incorporated
LOUISVILLE, KENTUCKY
New York · Philadelphia · Cleveland
Cincinnati · St. Louis · Chicago · Dallas

Data

Each unit has 4,197 sq. ft. of heating surface and generates 35,300 pounds steam per hour with 115 deg. superheat. * Water cooled bridge wall with Vogt armored tubes. * 225 pounds per square inch design pressure. * Air-cooled boiler setting. * Fuel—Coal screenings.

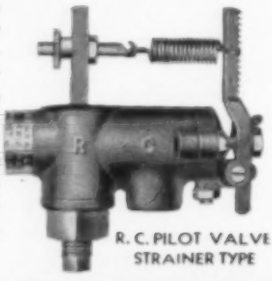
Consulting Engineers
Commercial Testing & Engineering Co.
Chicago, Illinois
R. H. Strang, *Plant Supt.*



Vogt **WATER TUBE BOILERS**
BENT TUBE, SECTIONAL HEADER & BOXHEADER TYPES

R. C. PILOT VALVES FOR POSITIVE CONTROL

R-C Unloader Pilot Valves (plain or strainer type) are standard on many leading compressors . . . installed as replacements on thousands of compressors in all parts of the U. S. A. and overseas. The R-C valve—positive in action—cannot chatter . . . it's always in open or closed position. Adjustment is provided for any unload-to-load range from 3% to 30% of maximum receiver pressure. Install an R-C Unloader Pilot valve—let performance prove its value. Specify air pressure and range of on-and-off operation desired. Write for price and recommendation.



R. C. PILOT VALVE
STRAINER TYPE

R. CONRADER CO.
1207 FRENCH STREET - ERIE, PA.
PILOT VALVES for Portable and Stationary Air Compressors provided with Unloaders

3 shifts a day . . .

SAFETY problems grow with mounting industrial activity. The danger is greater with new hands on hazardous jobs. Old hands become careless under increasing pressure. Keep production rolling and protect yourself and workmen by checking your safety equipment now. Call in a WILLSON Safety Service representative. He is a specialist in safety problems.

WILLSON has been a leader for years in designing and developing respiratory and eye protective devices. WILLSON Goggles, Gas Masks, Respirators and Helmets offer the most dependable, effective protection available. Send for new catalog with 40 pages crammed full of useful, up-to-date information on modern safety devices.

GOGGLES HELMETS
RESPIRATORS GAS MASKS

WILLSON
PRODUCTS INCORPORATED
READING, PA., U.S.A. Established 1870

"DriAir" gives Dry Air

DriAir hangs from the piping (above) or stands on the floor (below.) Being a separator and trap combined into a single unit, it requires no attachments, pipes straight through and when once installed requires no further attention.

The DriAir Separator separates and automatically ejects the condensed water from compressed air lines; collects rust, pipe scale, sediment and dirt from the pipes; delivers clean, dry air to tools and other pneumatic equipment. This promotes better and more uniform lubrication and prevents rapid wear, freezing and rusting of tools. The increase in production and the saving in tool depreciation quickly pay for the cost of installing the DriAir.

Do you want Bulletin DA and prices?

NEW JERSEY METER CO.

PLAINFIELD, NEW JERSEY

Air Meters DriAir Separators Air Jet Blowers

NAYLOR

the Light-weight Pipe for High and Low Pressure Lines!

Here's the kind of performance that has made Naylor the one light-weight pipe ideally suited for high or low pressure lines.

Naylor's exclusive Lockseam Spiralweld structure makes it leak-tight, flexible, stronger and safer than ordinary light-weight pipe.

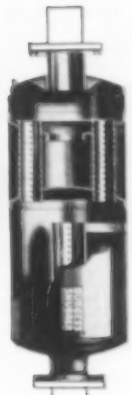
Sizes from 4" to 30" in diameter meet every requirement. All type fittings and connections. Complete fabrication service helps cut your installation costs.

• WRITE FOR CATALOG No. 37

NAYLOR PIPE COMPANY
1245 EAST NINETY-SECOND STREET
CHICAGO, ILLINOIS

NAYLOR LOCKSEAM SPIRALWELD PIPE

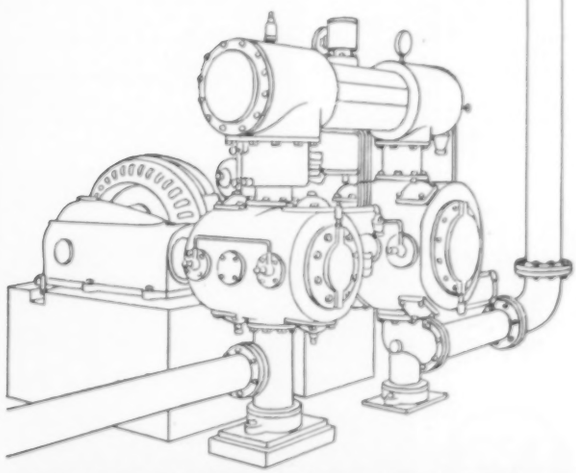
KILL COMPRESSOR INTAKE NOISE *this easy way*



Don't put up with compressor intake noise. Silence your compressor now—this easy way—by installing a Burgess SDI Intake Snubber. It stops all noise by snubbing the noisy slugs of inrushing air.

Compressor intake noise is due to constant fluctuations of air pressure in the intake system. Each pulsation produces a "pumping" noise. The Burgess Snubber eliminates this noise by preventing these pressure fluctuations. Air enters the intake in a smooth, steady flow. The Burgess Snubber design allows free air passage. It cannot "choke" the compressor.

Let us send you a new, illustrated bulletin describing Burgess Intake Snubbers.



BURGESS INTAKE SNUBBER

Patented and Patents Applied For

MAIL THIS COUPON FOR ILLUSTRATED BULLETIN

Burgess Battery Company, Acoustic Division
Dept. CA, 500 W. Huron Street, Chicago, Ill.

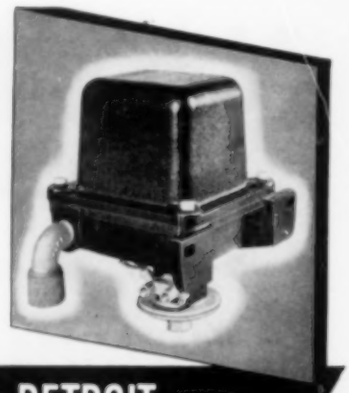
Please mail new bulletin describing Burgess Intake Snubber.

Name .....

Company .....

Address .....

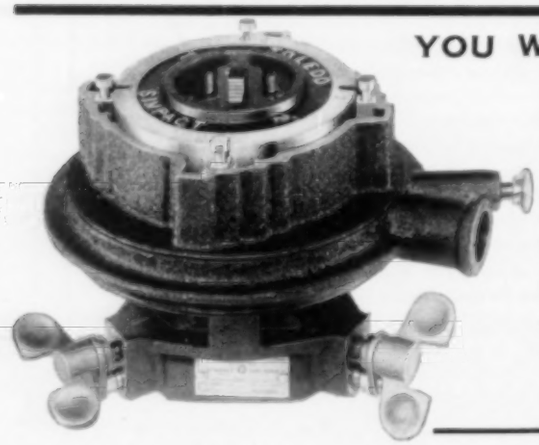
HERE IS AN *Explosion Proof* PRESSURE SWITCH



● The **CLASS 9013 TYPE AR** switch is built for use in Class I Group D hazardous locations. Top pressure 225 lbs.—standard air compressor settings—with or without release valve. Ratings are 2 H.P. 110 V., 3 H.P. 220 V. single phase and 5 H.P. 220-550 V. polyphase.

SWITCH • PROTECT • REGULATE • DO IT ALL WITH SQUARE D

SQUARE D COMPANY • REGULATOR DIVISION • DETROIT



YOU WILL LIKE A "TOLEDO" SIMPACT

1" to 2" self-contained ratchet threader, because it cuts easier, is lighter and is more compact than any other self-contained tool. Automatic drip oiling—oil pockets are filled at start of thread and oil continues to drip on dies and pipe as tool is revolved. Deep-throated high speed steel dies can be resharpened many times. Handle is 24" long. Adjustable rear guide with 3 chuck jaws is extremely easy to center on pipe.

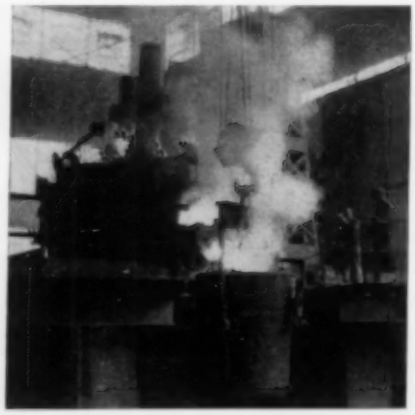
Buy this new "TOLEDO" SIMPACT from your dealer. You will like it.

THE TOLEDO PIPE THREADING MACHINE CO.

TOLEDO, OHIO NEW YORK OFFICE, 72 LAFAYETTE ST.

"TOLEDO"

Control —right from the start for—



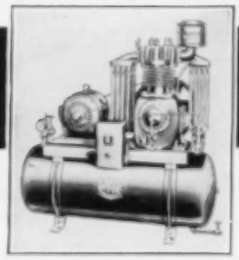
BASIC ELECTRIC STEEL FORGINGS

COMPLETE control of all processing from selection of the melting charge to the finished condition is the N. F. & O. *guarantee of quality* in forgings furnished to your specifications—Smooth Forged, Hollow Bored, Rough or Finished Machined.

NATIONAL FORGE & ORDNANCE CO.

IRVINE, WARREN COUNTY, PENNA. U. S. A.

IT PAYS TO USE



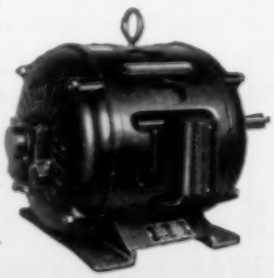
Industrial type Air Compressor powered by a 10-hp Wagner type RP-4 Motor

WAGNER MOTORS

ON YOUR PUMPS AND COMPRESSORS

Dependable operation of the equipment you use is of vital importance. Shut-downs caused by motor failure cost you money—not only for motor maintenance, but also in lost production time.

The proper selection of motors for your equipment will eliminate this unnecessary overhead. The performance records of Wagner motors now driving pumps and compressors prove that they give trouble-free service, even under the most severe operating conditions.



Wagner motors are varied mechanically to meet all operating conditions, and varied electrically to meet the requirements of different types of equipment.

Whether buying new equipment or replacing motors on equipment you have, it will pay you to specify WAGNER.

GET THE FACTS. Write for free bulletins MU-177 and MU-182.

M40-24

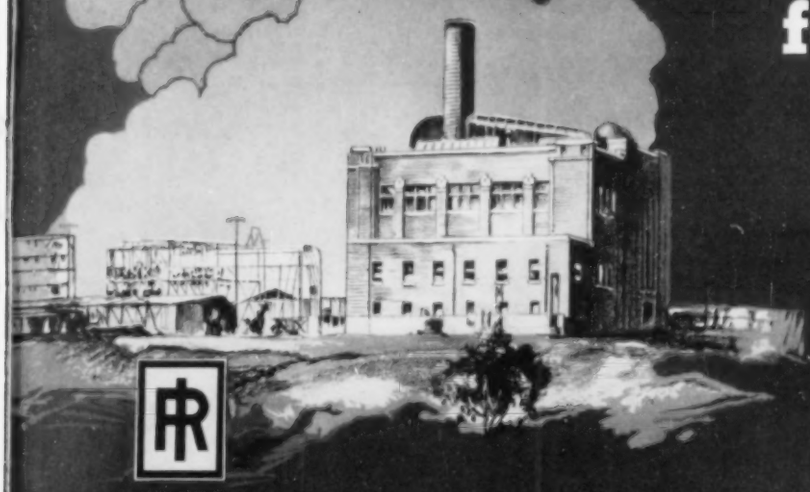
Wagner Electric Corporation

6400 Plymouth Avenue Saint Louis, Mo., U.S.A.

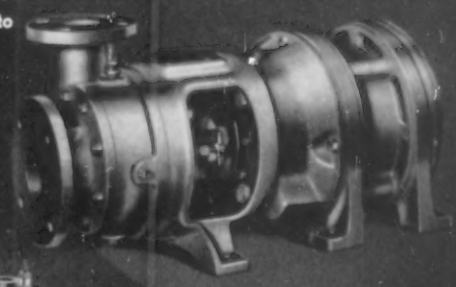
MOTORS • TRANSFORMERS • FANS • BRAKES

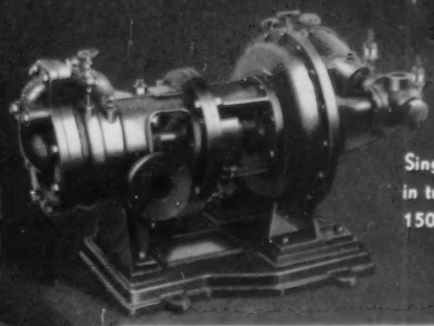
BOILER-FEED PUMPS

for all pressures

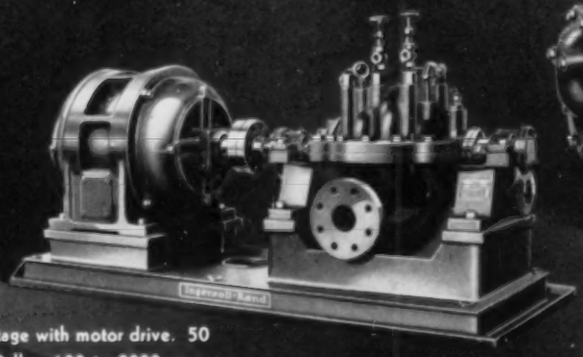


Single- or two-stage with built-in motor. 5 to 215 lb., 10 to 1500 gpm.





Single- or two-stage with built-in turbine. 5 to 215 lb., 10 to 1500 gpm.

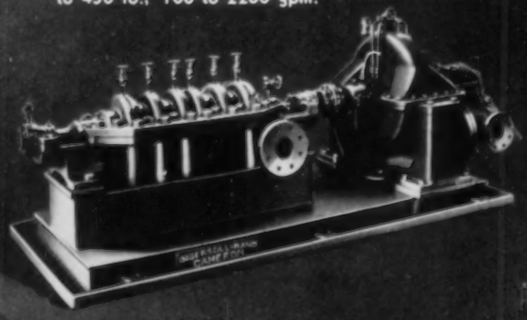


Two-stage with motor drive. 50 to 450 lb., 100 to 2200 gpm.

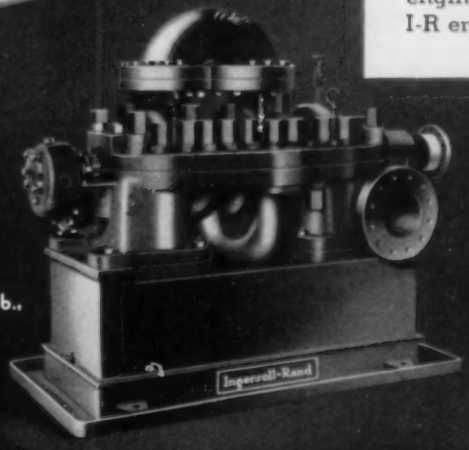
Regardless of the size of your plant or the boiler pressure, Ingersoll-Rand builds a feedwater pump to meet efficiently your exact conditions.

In addition, there is a complete line of pumps for water circulation, condensate and general industrial requirements. For efficiency and dependability, specify Ingersoll-Rand.

Other I-R power plant equipment includes compressors, condensers, air ejectors, blowers, Diesel engines, and pneumatic tools. Consult your nearest I-R engineer.

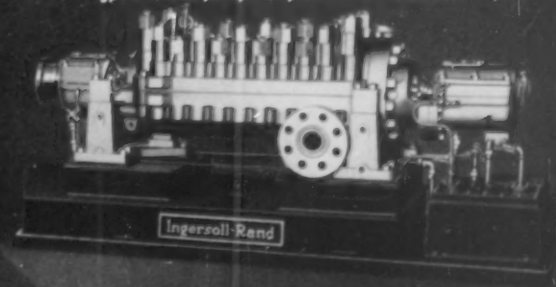


Multi-stage with turbine drive. 100 to 800 lb., 50 to 600 gpm.



Multi-stage. 200 to 1350 lb., 150 to 200 gpm.

Multi-stage. 1200 to 1800 lb., 150 to 1500 gpm. Other pumps for pressures to 3000 lb.



Atlanta
Birmingham
Boston
Buffalo
Butte
Chicago
Cincinnati
Cleveland
Dallas
Denver
Detroit
Duluth
El Paso
Hartford
Houston
Kansas City

Ingersoll-Rand

11 BROADWAY, NEW YORK CITY

921-10

Knoxville
Los Angeles
Newark
New Orleans
New York
Philadelphia
Picher
Pittsburgh
Pottsville
Salt Lake City
San Francisco
Scranton
Seattle
St. Louis
St. Paul
Tulsa
Washington

Contractors Report

OUTSTANDING RESULTS

. . . at Possum-Kingdom Dam Project

THE POSSUM-KINGDOM DAM on the Brazos River near Mineral Wells, Texas. Construction by C. F. Lytle and Al. Johnson, and R. W. Briggs & Co. . . . lubricated by Texaco.

BRIGGS' Allis-Chalmers 40" x 42" Jaw Crusher handled 325,000 yds. of aggregate in 14 months, without a bearing adjustment. *Texaco Marfak* used.

THESE TWO Sullivan Balanced Angle Air Compressors are subjected to heavy loading, yet are always up to maximum efficiency. *Texaco Algol Oil* is given full credit for its part in this performance.

SHOVELS AND TRUCKS operated by R. W. Briggs & Co. are always at peak, lubricated with *Texaco Marfak, Thuban, Crater.*

RUSHING completion of the Possum-Kingdom Dam Project, Mineral Wells, Texas, the C. F. Lytle and Al. Johnson Construction Co., and R. W. Briggs & Co. have enjoyed long, continuous service from their equipment.

Both of these contracting firms freely give credit to the lubricants used . . . TEXACO.

In 14 months, a big jaw crusher has handled 325,000 cu. yds. of concrete aggregate without need of a bearing adjustment. It is lubricated with *Texaco Marfak.*

On shovels, draglines and "Cats" they have had similar success . . . using *Texaco Ursa, Marfak, Thuban,* and *Crater.*

In 3 big air compressors operated by Lytle & Johnson Construction Co., *Texaco Algol Oil* keeps valves active and ports clean, resisting gumming and hard carbon formation. What little carbon forms is soft, fluffy, harmless.

Trained lubrication engineers will gladly cooperate in making savings with Texaco Lubricants in your equipment. Just phone the nearest of more than 2300 Texaco warehousing points in the 48 States, or write:

The Texas Company, 135 E. 42nd St., New York, N. Y.

Texaco Dealers invite you to tune in The Texaco Star Theatre—starring Kenny Baker and Frances Langford—Every Wednesday Night—Columbia Network. 9:00 E.D.T., 8:00 E.S.T., 8:00 C.D.T., 7:00 C.S.T., 6:00 M.S.T., 5:00 P.S.T.

TEXACO

REG. T.M.

TEXACO ALCAID, ALGOL, AND URSA OILS